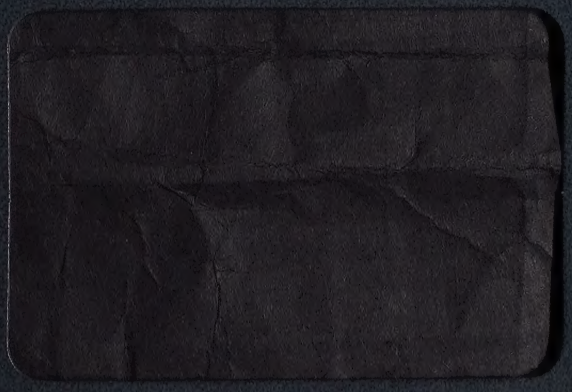
FLUKE®

Instruction Manual



INSTRUMENT SHOP

FLUKE®

Instruction Manual

NOTE

This manual documents the Model 5220A and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix 7A for older assemblies.

INSTRUMENT SHOP

A59600
MICROFICHED

Model

5220A

Transconductance Amplifier

INSTRUMENT SHOP

P/N 491936

June 1979

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or the nearest Service facility, giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC. will be happy to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX 43210, MOUNTLAKE TERRACE, WASHINGTON 98043, ATTEN: Sales Dept. For European Customers: Fluke (Nederland) B.V., Zevenheuvelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., • P.O. Box 43210 • Mountlake Terrace, Washington 98043

GENE HACKETT
727-8121

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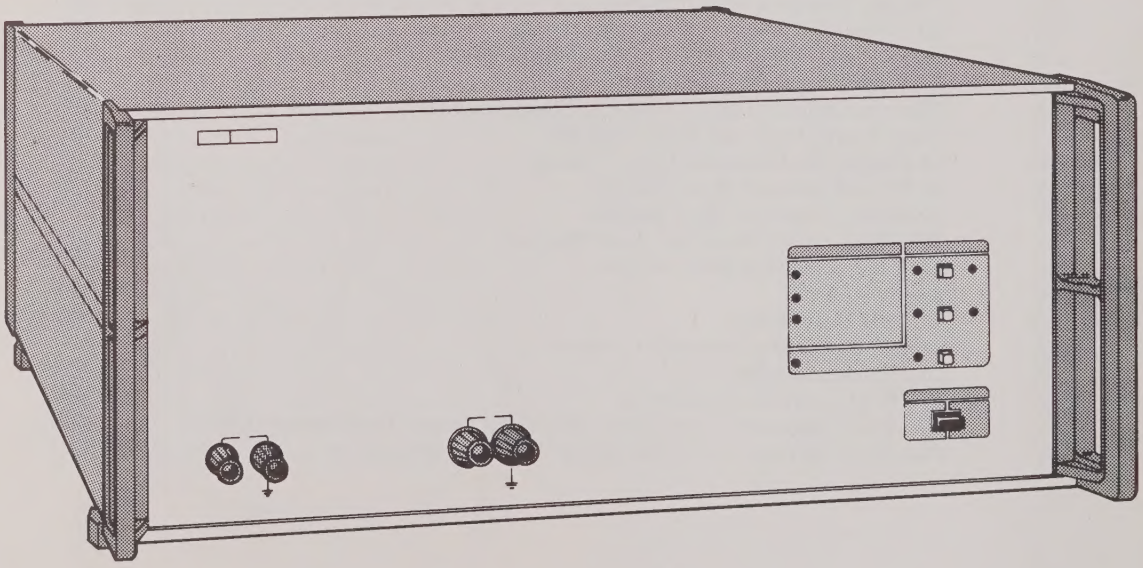


5220A Transconductance Amplifier

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 5220A is a transconductance amplifier designed to operate as either a stand alone unit or an extension of the Fluke Model 5100 Series Calibrator. Functionally, the instrument operates as a precision ac/dc current source for calibrating current shunts and/or current meters. As the name (transconductance amplifier) implies, the output current level is a function of an input control voltage. The input/output ratio is established at 1:1 so that a voltage input in the range of -20 to +20 volts will produce a proportional current output of -20 to +20 amperes. Input voltages may be either dc or ac levels depending on the output requirements. Bandwidth for ac operation is dc to 5 kHz.

1-3. Control of the 5220A can be handled locally using front panel controls or remotely by way of the 5100 Series Calibrator. (The 5100 must be equipped with a Model Y5000 Interface.) Control mode selection is accomplished using two front-panel pushbutton switches, INPUT and LOCAL. The INPUT switch allows selection of either front or rear control-voltage input connections. The LOCAL switch is used to recall the 5220A from remote to local operation.

1-4. A series of front panel indicators is used to visually display both the control and operating status of the 5220A. Control indicators include OPER (operate), STDBY (standby), FRONT input, REAR input, REMOTE, and LOCAL LOCKOUT. The combination of lit LEDs indicates the present status of the control mode. Status indicators include THERMAL CUT-OFF, OVERCOMPLIANCE, and OVERCURRENT. When any one of these indicators is lit, an overload condition has been detected causing the 5220A to switch to standby operation. All indicators are active regardless of the selected control mode, local or remote.

1-5. Current output connections are provided on both the front and rear panels. However, only one set of terminals is active. Selection of the desired set is accomplished internally and is, therefore, not considered an operator function. Neither local nor remote operation is affected by the selection of front or rear output.

1-6. Forced-air circulation is incorporated in the 5220A to ensure adequate cooling of the current output stage. Air is pulled in through a rear-panel filter, passed over the output stage heat sink, and exhausted through the unit's side panels.

1-7. The 5220A is designed to operate from ac line voltages within the range of 90V ac to 264V ac, 50 to 60 Hz. One-of-eight specific voltages (100, 110, 115, 120, 200, 220, 230, 240V ac ±10%) can be selected to ensure compatibility with the local line voltage. The selection switches are inside the 5220A. Refer to Section 4 of this manual for information on how to properly set the line power switches.

1-8. Accessories available for use with the 5220A are listed and described in Table 1-1. The rack mounting kits are designed for use with a standard 19-inch equipment rack. The Model Y5020A is a precision current shunt recommended for use in calibrating the 5220A. Specify both model number and description when ordering accessories.

1-9. SPECIFICATIONS

1-10. Specifications for the Model 5220A are given in Table 1-2.

Table 1-1. Accessories

MODEL NO.	DESCRIPTION
M07-205-600	Rack Mounting Kit
M00-260-610	Rack Slide Kit, 18-inch
M00-280-610	Rack Slide Kit, 24-inch
Y5020	Precision Shunt

Table 1-2. Specifications

CALIBRATION CYCLE	All specifications are valid for a 180-day period at an operating temperature of 20°C to 30°C and a relative humidity of 70% or less.
BASIC	
Transconductance	1 Siemen (1 ampere per volt)
Output Range	0 to 20A dc or rms ac (28.3A peak)
Compliance Voltage	⩾±4V dc, or 3V rms ac (4.25V peak)
DC Accuracy	±(0.025% of output +1 mA)
AC Accuracy	±(0.05% of output +1 mA) from 30 Hz to 1 kHz, and ±(0.05% of output +1 mA) x f from 1 kHz to 5 kHz, where f = frequency in kHz.
Short Term DC Stability	Output changes less than ±(0.005% +200 μA) in 10 minutes, with constant line, load, and temperature.
Short Term AC Stability	Output changes less than ±(0.01% +500 μA) in 10 minutes, with constant line, load, and temperature.
Harmonic Distortion and Noise	±(0.05% of output ±1 mA rms) over frequency range of 30 Hz to 1 kHz and measured with a noise bandwidth of 300 kHz, ±(0.05% of output +1 mA) x f from 1 kHz to 5 kHz, where f = frequency in kHz.
Temperature Coefficient	±(0.0025% of output +100 μA per degree C, above 30°C or below 20°C.
Transient Recovery	Output will settle to within 0.01% of final value within 2 seconds following a programmed change in output current or frequency (10 ms for 5220A alone).
DC MODE (Including 5100 Series B)	
Output Range	±1 to ±19.9999A
Accuracy of Output	±(0.025% of selected output +1 mA)
Resolution	±0.1 mA
Temperature Coefficient	±(0.003% of selected output +100 μA) in 10 minutes, with constant line, load, and temperature
Line Regulation	Output changes less than 0.001% for a ±10% change in line voltage
Load Regulation	Output changes less than ±(0.005% +100 μA) for a full load change of 4 volts of compliance.
AC MODE (Including 5100 Series B)	
Output Range	1A rms to 19.9999A rms
Accuracy of Output	±(0.07% of selected output +1 mA rms) from 50 Hz to 1 kHz, and ±(0.07% of selected output +1 mA rms) x f from 1 kHz to 5 kHz, where f = frequency in kHz.
Resolution	±0.1 mA rms
Temperature Coefficient	±(0.003% of selected output +100 μA rms) per degree C, above 30°C and below 20°C.
Short Term Stability	Output changes less than ±(0.02% +500 μA rms) in 10 minutes, with constant line, load, and temperature.
Harmonic Distortion and Noise	±(0.07% of output +1 mA rms) over frequency range of 30 Hz to 1 kHz a noise bandwidth of 300 kHz, ±(0.07% of output +1 mA) x f from 1 kHz to 5 kHz, where f = frequency in Hz.
Line Regulation	Output changes less than 0.005% for ±10% change in line voltage.
Load Regulation	Output changes less than 0.005% for each 1-volt change in compliance voltage.

GENERAL

Load Capability	Drives all resistive and capacitive loads consistent with current and compliance voltage capability. Drives inductive loads (with reduced accuracy) up to 200 microhenries, consistent with current and compliance voltage capability.
Maximum Isolation Voltage	±20V dc or 20V ac rms
Temperature Range	0°C to 50°C (operating) and −20°C to 65°C (storage).
Relative Humidity	50% to 50° C, 75% to 40°C, 95% to 25°C.
Altitude	0 to 10,000 feet (operating) and 0 to 40,000 feet (non-operating)
Vibration	2g maximum, 5 Hz to 55 Hz for 15 minutes.
Shock	15g maximum, half sinewave.
Power Requirements	100, 110, 115, 120, 200, 220, 230, or 240V ac ±10%, switch-selectable, 50 Hz to 60 Hz, 300 watts.
Weight	227 kg (50 lbs)
Dimensions	17.8 cm H x 43.2 cm W x 55.9 cm D (7" H x 17" W x 22" D), Case only, (See Figure 1-1.)
Protection Safety Class 1	Relates solely to insulation or grounding properties as defined in IEC 348.

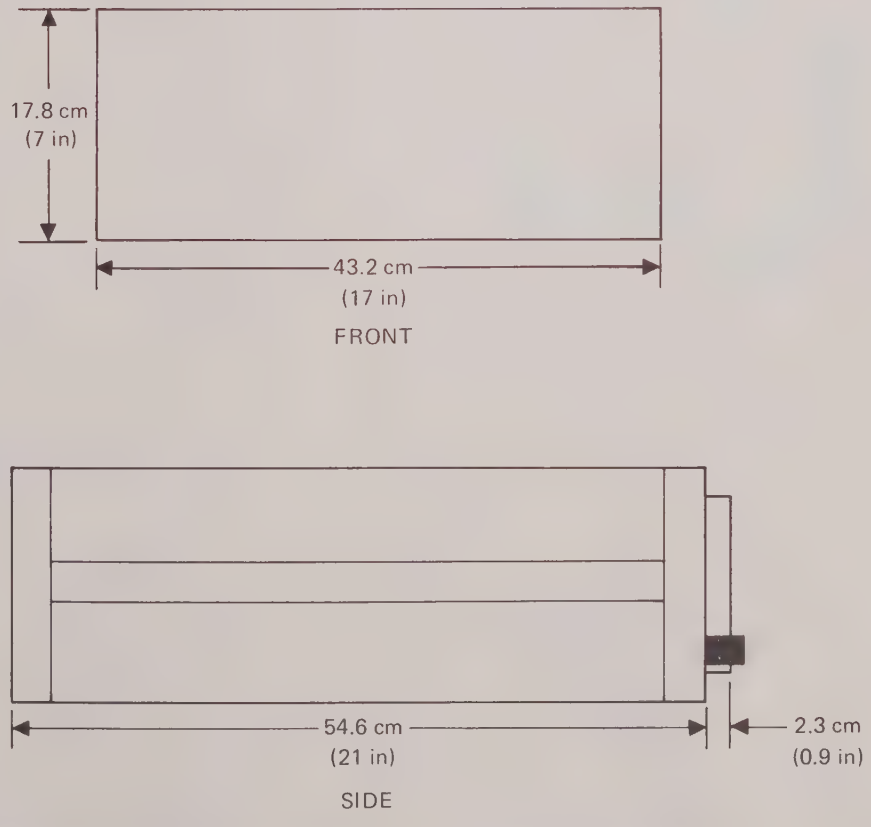
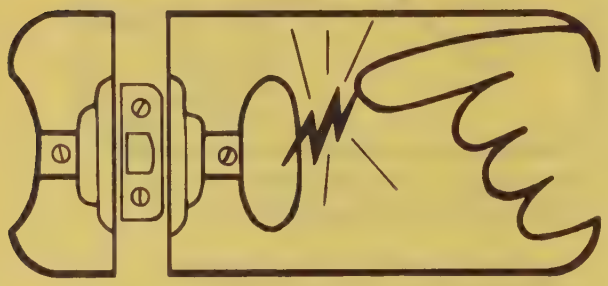


Figure 1-1. Outline Drawings

static awareness

A Message From

John Fluke Mfg. Co., Inc.



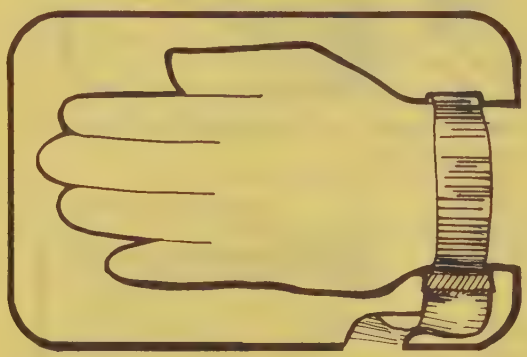
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

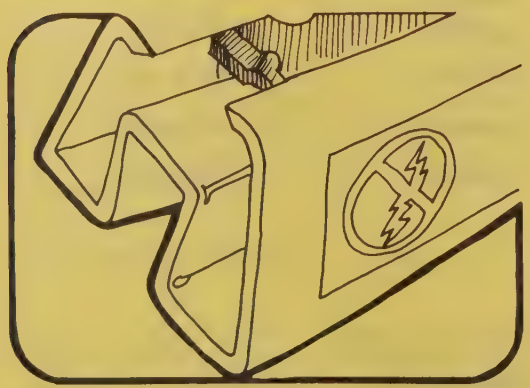
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol " ⊗ ".

The following practices should be followed to minimize damage to S.S. devices.

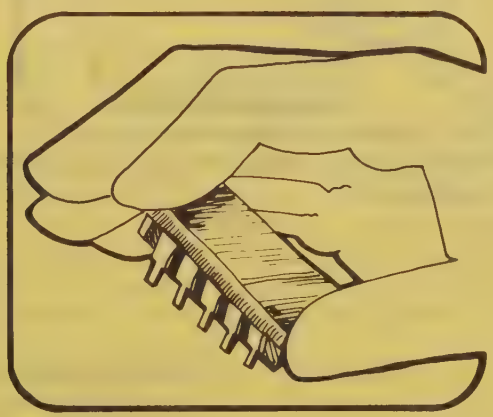
1. MINIMIZE HANDLING



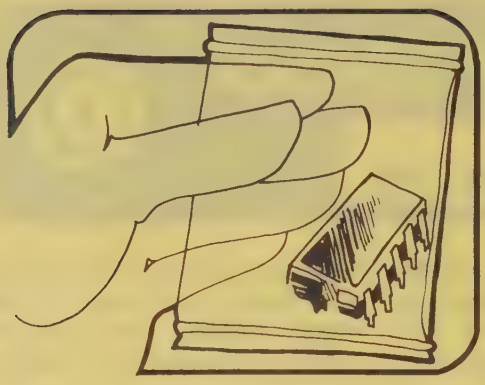
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



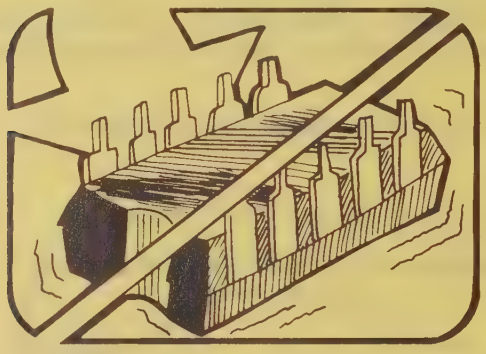
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



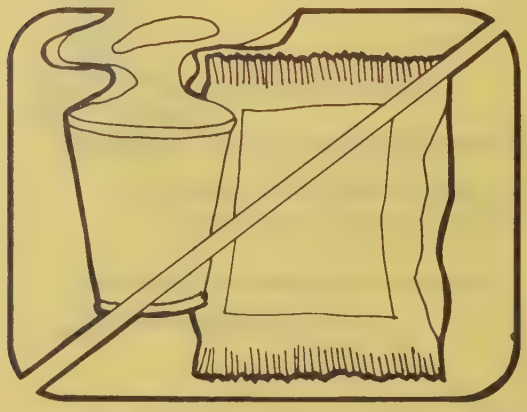
4. HANDLE S.S. DEVICES BY THE BODY



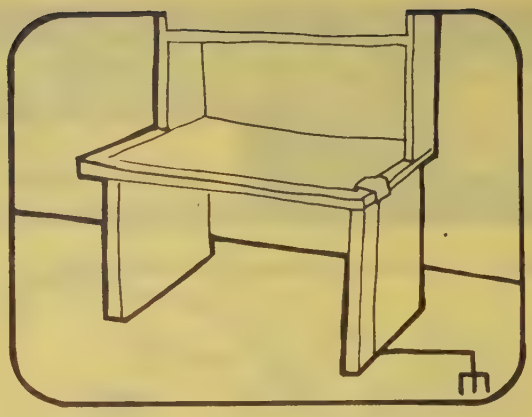
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

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Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information concerning the installation and operation of the Model 5220A Tranconductance Amplifier. It is recommended that the contents of this section be read and understood before any attempt is made to operate the unit. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative, or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of sales representatives is given in Section 7.

2-3. SHIPPING INFORMATION

2-4. The 5220A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument's model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 5220A can be operated from any one of the following 50 to 60 Hz (±1%) line voltages: 100, 110, 115, 120, 200, 220, 230, or 240V ac (±10%). A rear panel decal specifies the voltage selected prior to shipment. If a change in voltage is required, refer to Section 4 of this manual for the selection procedure.

2-8. FUSE REPLACEMENT

2-9. AC Line Fuse

2-10. The ac line fuse is accessible by way of a rear-panel fuse holder located to the left of the input power connector. If fuse replacement is required, disconnect the 5220A from line power and remove the fuse cap and fuse (twist the fuse cap ccw using a screwdriver). Select and install a replacement fuse whose rating is compatible with the local line voltage.

1. 100 to 120V ac use fuse type MDA 3A
2. 200 to 240V ac use fuse type MDX 1.5A

2-11. Power Supply Fuses

2-12. Each of the secondary windings on the power transformer is fused to protect the power supplies from damage in the event of an overload. These fuses, six in all, are internal to the 5220A and are not available to the operator. Details for replacement by qualified personnel are given in Section 4 of this manual.

2-13. RACK INSTALLATION

2-14. The 5220A is designed for either bench-top use or for installation in a standard 19-inch equipment rack using the accessory Rack Mounting Kit (John Fluke P/N M08-205-600). Chassis slides (John Fluke P/N M00-280-610) can also be installed to facilitate access to the instrument when it is installed in an equipment rack. Information regarding the installation of the rack-mounting accessories is included in Section 6.

2-15. OPERATING FEATURES

2-16. The function and location of all 5220A controls, indicators, and connectors are shown in Figure 2-1 and described in Table 2-1.

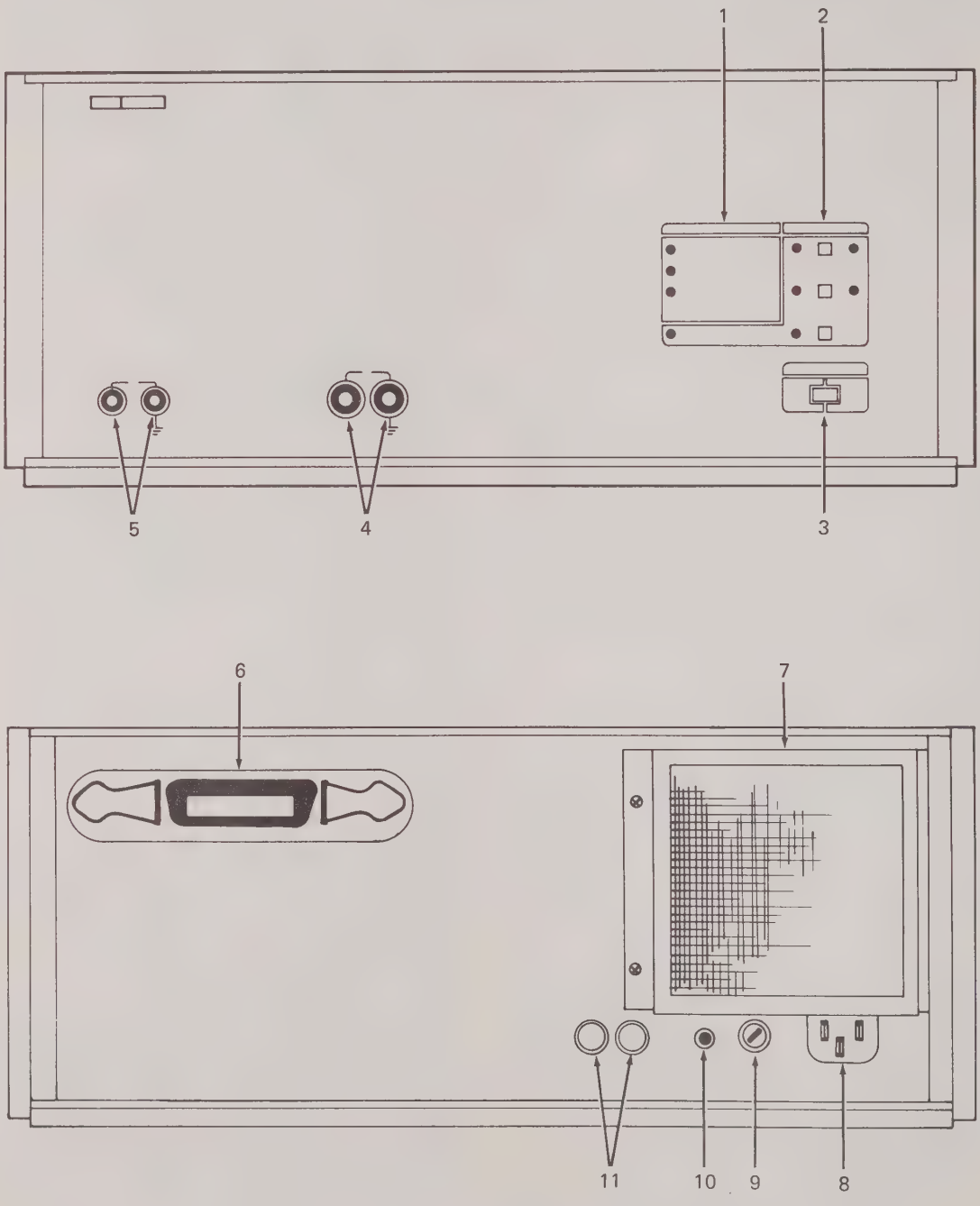


Figure 2-1. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators and Connectors

REF NO.	NAME	FUNCTION
1	STATUS Indicators	Three LEDs that light on an individual basis to indicate that the 5220A has exceeded an operating limit. When the limit condition is detected the 5220A is switched to the standby mode. When the limit condition is cleared the LED will remain lit until the 5220A is commanded to the operate mode. The three status conditions are as follows: THERMAL CUTOFF — Indicates that the output stage of the 5220A has exceeded its maximum operating temperature. OVERCOMPLIANCE — Indicates that the compliance voltage at the output terminals has exceeded its limit. OVERCURRENT — Indicates that the output current has been programmed beyond its upper limit.
2	CONTROL Switches and Indicators	A series of pushbutton switches and LEDs used to select and indicate the 5220A operating mode. The function of each is as follows: OPR/STDBY Switch — Allows alternate selection of the standby and operate modes. INPUT Switch — Allows alternate selection of the front and rear input connectors. REMOTE Switch — Allows recall of the local mode when remote is enabled and the LOCAL LOCKOUT LED is not lit. OPR/STDBY LEDs — One of the two is lit to indicate the current operating mode, operate or standby. FRONT/REAR LEDs — One is lit to indicate the selected voltage input connector, front or rear. REMOTE LED — Lights to indicate that the remote mode has been remotely selected. If the LED is not lit the local mode is enabled. LOCAL LOCKOUT LED — Lights to indicate that the unit has been remotely locked in the remote mode. In this event, the three front panel CONTROL switches are disabled.
3	POWER Switch	A push-push switch used to switch instrument power on and off.
4	CURRENT OUTPUT Terminals (Front)	A pair of banana-jack terminals used to provide front-panel connection to the output of the current source. The terminals are inactive when the rear-panel output terminals are selected.
5	VOLTAGE INPUT Terminals (Front)	A pair of banana-jack terminals that serve as control voltage input connections in the local/front-input mode.
6	MIS* Bus Connector	A 24-pin connector used as an I/O port for remote operation (Fluke MIS Bus) of the 5220A. When the 5220A is interfaced with a 5100 Series Calibrator (by way of a Y5000 Interface) the 5220A output can be controlled from the 5100 front panel.

* MIS = Modular Instrument System

Table 2-1. Controls, Indicators and Connectors (cont)

7	Ventilation Filter	Prevents dirt and debris from being drawn into the 5220A intake ventilation port.
8	Power Connector	Provides the means of connecting the 5220A to ac line power by way of a 3-wire power cord.
9	Fuse Holder	Houses the ac line fuse and allows easy access for fuse replacement.
10	Ground Connector	A binding post positioned to provide a convenient connection to chassis ground.
11	Current Output Terminals (Rear)	A pair of banana-jack terminals used as rear-panel current output connections. The terminals are inactive when the front-panel CURRENT OUTPUT terminals are selected.

2-17. OPERATING NOTES

2-18. The following paragraphs describe the various conditions which should be considered before operating the 5220A.

2-19. AC Line Connection

2-20. The rear-panel, three-prong, U-ground connector permits the 5220A to be connected, through a power cord, to 50 or 60 Hz line power. The offset prong on this connector is connected to the 5220A chassis and should be connected, via the power cord, to a high-quality earth ground.

2-21. Transconductance Amplifier

2-22. A transconductance amplifier is a current source whose output current level is proportional to an analog input voltage. Electrically, the output of the unit appears as a constant current source with an output impedance that is much greater than the load resistance. Similarly, its input impedance is much greater than that of the input voltage source.

2-23. The input/output ratio of the 5220A is 1:1, and the output current range is +20 to –20 amperes. Therefore, the range of the input control voltage is +20 to –20V dc. The compliance voltage of the 5220A is 3V rms ac or ±4V dc.

2-24. Input Voltage Requirements

2-25. Input control voltage for the 5220A can be supplied by any low-impedance voltage source with an output proportional to the desired output current. The source may be either ac (30 Hz to 1 kHz) or dc, fixed or adjustable, depending upon the output requirements.

2-26. The control voltage source may be connected to either the front-panel VOLTAGE INPUT terminals or the rear-panel voltage input terminals (Pins 5 (low) and 6 (high) of the 24-pin connector), but not both simultaneously. Instrument damage will not result from the simultaneous connection of two sources. However, interaction between the two inputs can result in source loading, which in turn can cause inaccuracy in the expected current output level.

2-27. If a rear panel input is desirable, the use of the 5100 Series Calibrator and a Y5000 Interface is recommended. This combination allows the 5220A to be operated remotely as an extension of the 5100. If the use of an alternate rear-input source is desirable, the user is responsible for the proper interface. Details for custom interface requirements can be derived from the theory of operation (Section 3) and the detailed schematics (Section 8).

2-28. Input Voltage Selection, Front/Rear

2-29. Selection of the front or rear terminals for control voltage input is manually accomplished by pressing the INPUT pushbutton switch on the front panel. Each depression alternately selects front or rear as indicated by the lit FRONT/REAR LED indicator. This switch is active in the local mode, and inactive in the remote mode.

2-30. Current Output, Front/Rear

2-31. The 5220A current output can be taken from either a front- or rear-panel set of five-way binding post terminals, but not both simultaneously. An internal jumper configuration allows qualified personnel to establish the desired output. A detailed output selection procedure is given in Section 4, Maintenance.

2-32. Standby/Operate

2-33. When the 5220A is energized it can be placed into one-of-two operating modes; standby or operate. The enabled mode is indicated by a lit front panel LED; OPR (operate) or STDBY (standby). Standby is essentially a reset state, in which the output of the transconductance amplifier is forced to zero regardless of the input control voltage level. In the standby mode both the amplifier and the device connected to its output are protected from accidental overloads. The operate mode is enabled when an output is required. It causes the amplifier to respond to the control voltage input, and thereby provides the appropriate current level output.

2-34. A front panel pushbutton switch (located between the OPR/STDBY LEDs) allows manual selection of either mode when the LOCAL LOCKOUT LED is not lit. However, the selection can be counteracted under certain conditions. For example, either mode may be remotely selected, and the detection of an output overload will command the standby mode. Similarly, when the unit is initially energized it is forced to standby.

2-35. Local/Remote

2-36. The 5220A can be operated manually using the front panel controls, or remotely by way of the rear panel connector. When the unit is initially energized, it is forced to the local control mode (REMOTE LED is not lit). The remote mode can only be selected by way of a remote control source. When remote is enabled (REMOTE LED is lit) the local mode can be recalled by a remote command or by pressing the LOCAL pushbutton switch on the front panel. However, if the LOCAL LOCKOUT is lit (this is also a remote command) the local mode can only be recalled by a remote command.

2-37. Status Indicators

2-38. A series of three front-panel STATUS LEDs provide a visual indication of overload conditions that have been detected at the 5220A output. They are: THERMAL CUTOFF, OVERCOMPLIANCE, and OVERCURRENT. When any one of these conditions is detected the appropriate LED is lit and the unit is commanded to standby. The LED will remain lit even after the overload condition has been relieved. To return the unit to the operate mode the overload must be cleared and the operate mode must be commanded. If operate is commanded while the overload is still present, the unit will remain in standby.

2-39. A thermal cutoff indication identifies overheating of the current output stage. If the heating is excessive a cooling-down period may be required before the condition is cleared.

2-40. The presence of an open-circuit or a high impedance load at the output terminals will cause an overcompliance indication. In this case, an appropriate load will have to be connected to the output before the condition can be cleared. Overcompliance is detected as an output voltage outside the range of ±4V dc or 3V rms ac.

2-41. Output current in excess of 20 amperes will cause an overcurrent indication. To correct the condition, the input control voltage must be reduced to an acceptable level.

2-42. Audible Output

2-43. When the 5220A is used to output high current at high frequencies (above 10 amperes and 1 kHz) it may emit an audible tone. The sound is normal and is characteristic of power transistors that are operated at high current density. Several factors will cause the sound to be more or less apparent. They include background noise, location of the 5220A relative to the operator, and operator's hearing ability.

2-44. Inductive Loads

2-45. The 5220A will drive an inductive load of up to 200 microhenries. However, reasonable care must be exercised to ensure the desired results. One or more of the following considerations may apply to a given application:

1. Compliance voltage (3.0V maximum) places a restriction on the product of inductance and operating frequency for a given output current. This is illustrated in Figure 2-2 for maximum load inductance vs frequency at output currents of 5, 10, and 20 amperes.

2. A step change in output current into an inductive load can easily produce an overcompliance condition. If the control voltage is being input at the front panel terminals, the rate of change must be controlled to avoid an overcompliance trip. An alternate approach is to set the 5220A to standby before making a change in the control voltage, then select the operate mode. This allows the 5220A to internally control the rate of change. If the control voltage is taken from a Fluke Model 5100 Series Calibrator, the calibrator will limit its output to an acceptable rate of change.

3. The leads used to connect a load to the 5220A can add appreciably to load inductance. For example, a pair of 5 foot leads (10 feet of wire) made of 18 gauge wire (AWG) will have a calculated inductance of 3.86 microhenries. This is enough to cause an overcompliance trip if a step change in the input control voltage occurs.

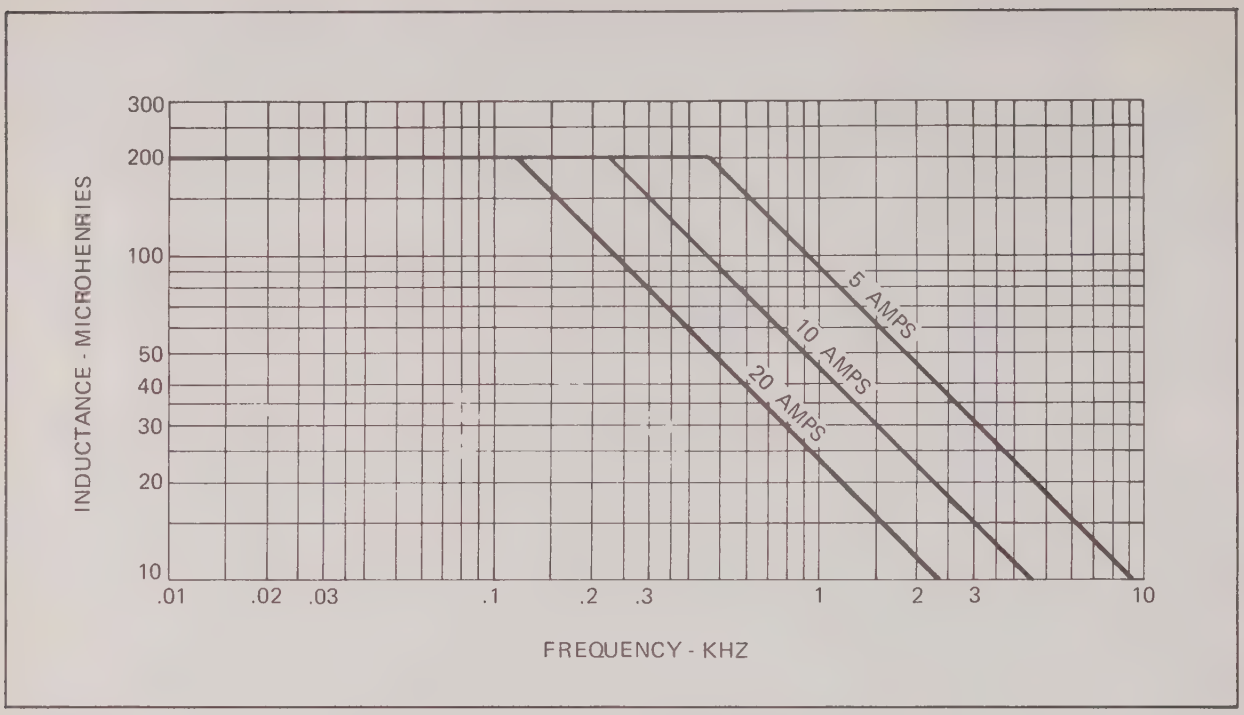


Figure 2-2. Maximum Load Inductance vs Frequency

4. When driving an ac current through an inductive load the 5220A will exhibit increased distortion and tranconductance error. This is due to a reduction in loop gain caused by the inductance. The graph in Figure 2-3 illustrates the typical transconductance error, as a function of frequency, for two different inductive load values.

2-46. OPERATION

2-47. The following procedure is suggested for operating the 5220A. With reference to the previous paragraphs proceed as follows:

1. Connect the 5220A to the 5100 Series Calibrator via the Y5000 Interface if remote operation is desired. See the 5100B/Y5000 Instruction Manuals for details.

2. Connect the 5220A to line power.

3. Turn-on the 5220A by depressing the POWER switch to the ON position. Only the STDBY and FRONT indicators should be lit.

4. Energize peripheral equipment as required.

5. If local operation is required, connect the control voltage source to the front-panel VOLTAGE INPUT terminals.

6. Adjust the output of the control voltage source (remote or local) to approximately 1 volt.

7. Determine the active output terminals (front or rear) by connecting a short jumper wire between the front-panel CURRENT OUTPUT terminals and then pressing the OPR/STDBY switch. If the OVERCOMPLIANCE LED lights, the rear output terminals are active. Otherwise, the OPR LED will light indicating that the front CURRENT OUTPUT terminals are active.

8. Press the STDBY switch and then remove the short from the front output terminals.

9. Connect the intended load between the active output terminals.

10. Adjust the control voltage to the desired level.

11. Command the operate mode. If the OPR LED is lit, the predetermined current level is flowing through the load.

12. Set the unit to standby before disconnecting the load or setting the POWER switch to OFF.

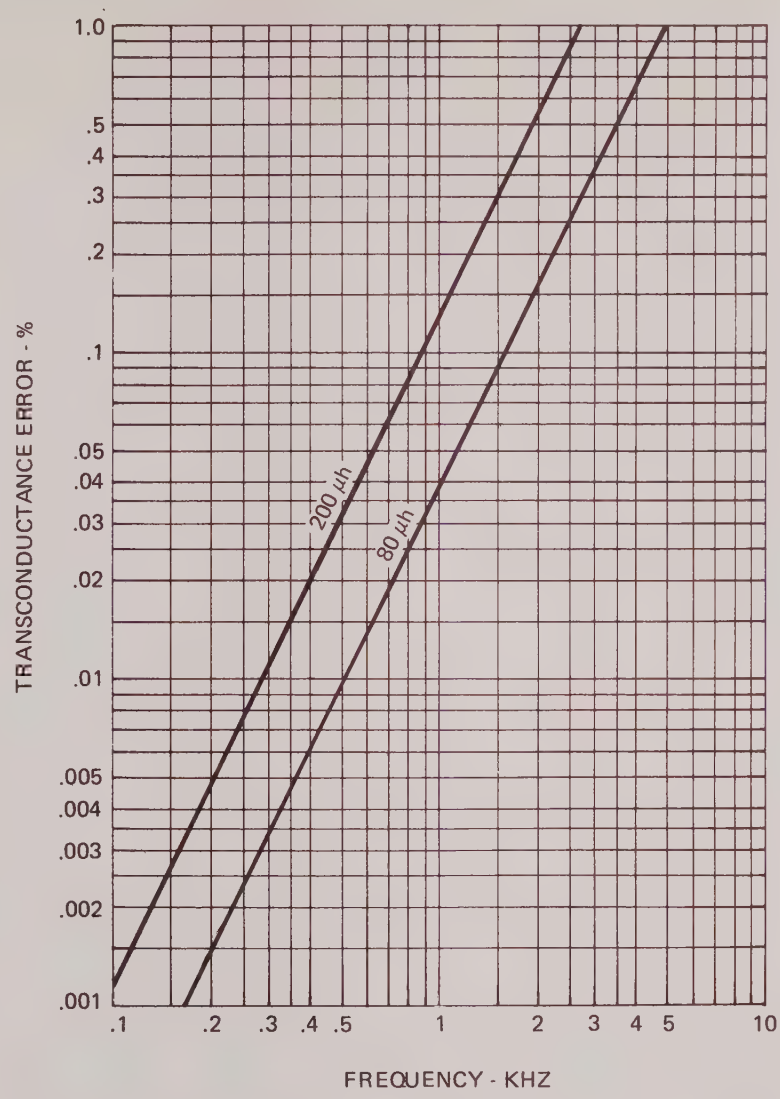


Figure 2-3. Typical Transconductance Error for Inductive Loads

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a detailed circuit analysis of the 5220A. Both descriptions are supported by block diagrams. Component level descriptions contained in the circuit analysis are referenced to the detailed schematics in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. General

3-5. The 5220A is a transconductance amplifier. That is, a current source whose output current is proportional to an analog input voltage. Electrically viewed at the output terminals, the 5220A appears as a current source with an output impedance that is very much greater than the load resistance. Its input terminals exhibit a similar characteristic; the input impedance is larger than that of the input voltage source.

3-6. Functionally, the 5220A, as shown in Figure 3-1, can be divided into two sections, analog and digital. The analog section consists of the power supplies, the transconductance amplifier, and associated analog control circuitry. The digital section comprises the logic necessary for overall control, and the interfaces necessary for front panel (local) operation and remote operation by way of the Fluke MIS Bus.

3-7. Analog Section

3-8. The power supply used in the 5220A provides operating voltages for both the analog and the digital section of the unit. It consists of three separate assemblies: the A2 Transformer Assembly, the A3 Cap Bus, and the A4 Regulator. The Cap Bus and Regulator Assemblies comprise the output portion of the supply, while the Transformer Assembly provides isolated ac power for the power supplies. Regulated supply voltages are a function of the A4 Regulator. These include, +5V dc and +5V dc Isolated for the digital circuits, and +15/–15V dc for analog ciruit operation. Unregulated voltages are a function of the A3 Cap Bus. The Cap Bus is a high-current, +12/–12V dc source for the 5220A current output.

3-9. The transconductance amplifier is a three-stage, closed-loop amplifier whose feedback signal is proportional to the 5220A output (load) current. It consists of the A5 Preamp, the A6 Driver, the A7 Output, and a precision four-terminal shunt. Input voltage to the amplifier is presented, by way of front or rear input terminals, to the A5 Preamp. This assembly includes relays for front/rear input selection, precision feedback resistors to establish overall loop gain, and a high-gain amplifier equipped with on/off control for power-on/off sequencing and failure control. The output of the A5 Preamp is input directly to the A6 Driver where it is buffered and passed on as a differential input to the high-current A7 Output stage. Output current from this stage is returned through the output load and a precision current shunt to power supply common (COM 2) of the A3 Cap Bus (high-current supply). The voltage drop that occurs across the shunt is sent to the A5 Preamp as a feedback signal, thus closing the loop.

3-10. Overall operation of the transconductance amplifier is illustrated in Figure 3-2. When an input voltage, EIN, is applied to the amplifier an output current, IOUT, is produced. The current passes through the series connected load and the precision shunt, RS. Current passing through the shunt produces a voltage (IR) drop, EOUT, whose polarity (with respect to COM 1) is opposite that of the input voltage. This voltage is returned to the amplifier as negative feedback through resistor R2. The values of R1, R2, and RS established the 1:1 ratio of input voltage to output current. See equations in Figure 3-2.

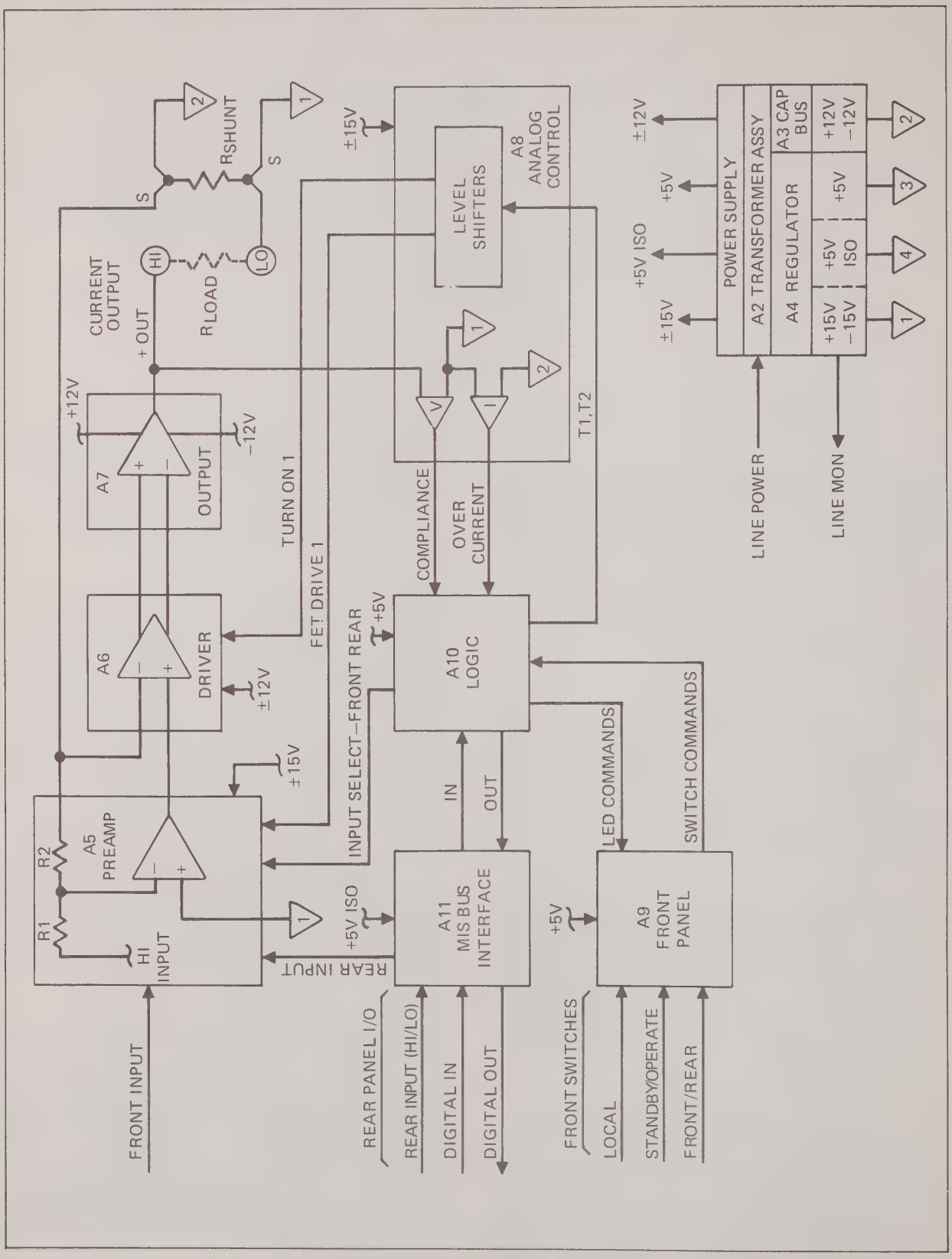


Figure 3-1. 5220A Functional Block Diagram

3-11. The analog control circuit constantly monitors the voltage and current outputs of the transconductance amplifier and provides overcompliance and overcurrent indications to the digital section of the 5220A. When an overload condition occurs, the digital section responds by sending shut-down signals to the amplifier by way of the analog control logic. Control sequencing signals (T1, T2) for amplifier turn-on are also processed by the analog control circuit.

3-12. Digital Section

3-13. The logic portion of the 5220A controls the sequencing of input relays (front/rear) and other contol signals which turn the transconductance amplifier on and off. It also provides drive commands to light appropriate front panel status LEDs. Inputs to the logic are in the form of local/remote control commands from the front panel switches or the remote MIS Bus Interface, and overload signals from the analog control circuit.

3-14. Local or front panel control of the 5220A is accomplished through a series of front panel pushbutton switches which provide direct inputs to the logic circuit. Control and/or status responses to the commands are displayed on the front panel LEDs.

3-15. Remote control of the 5220A is enabled by the A11 MIS Bus Interface. The interface is intended for use with a 5100 Series Calibrator equipped with a Y5000 Interface. Control data (analog and digital) is received at the A11 MIS Bus Interface by way of a connector on the rear panel of the 5220A. In the remote mode, this data is processed by the interface and internally coupled with the analog and digital sections of the 5220A.

3-16. CIRCUIT ANALYSIS

3-17. A detailed circuit description of the 5220A is given in the following paragraphs. The description is keyed to the functional blocks defined in Figure 3-1. Each block is described separately and is supported by both a block diagram and a detailed schematic diagram (see Section 8 for schematics).

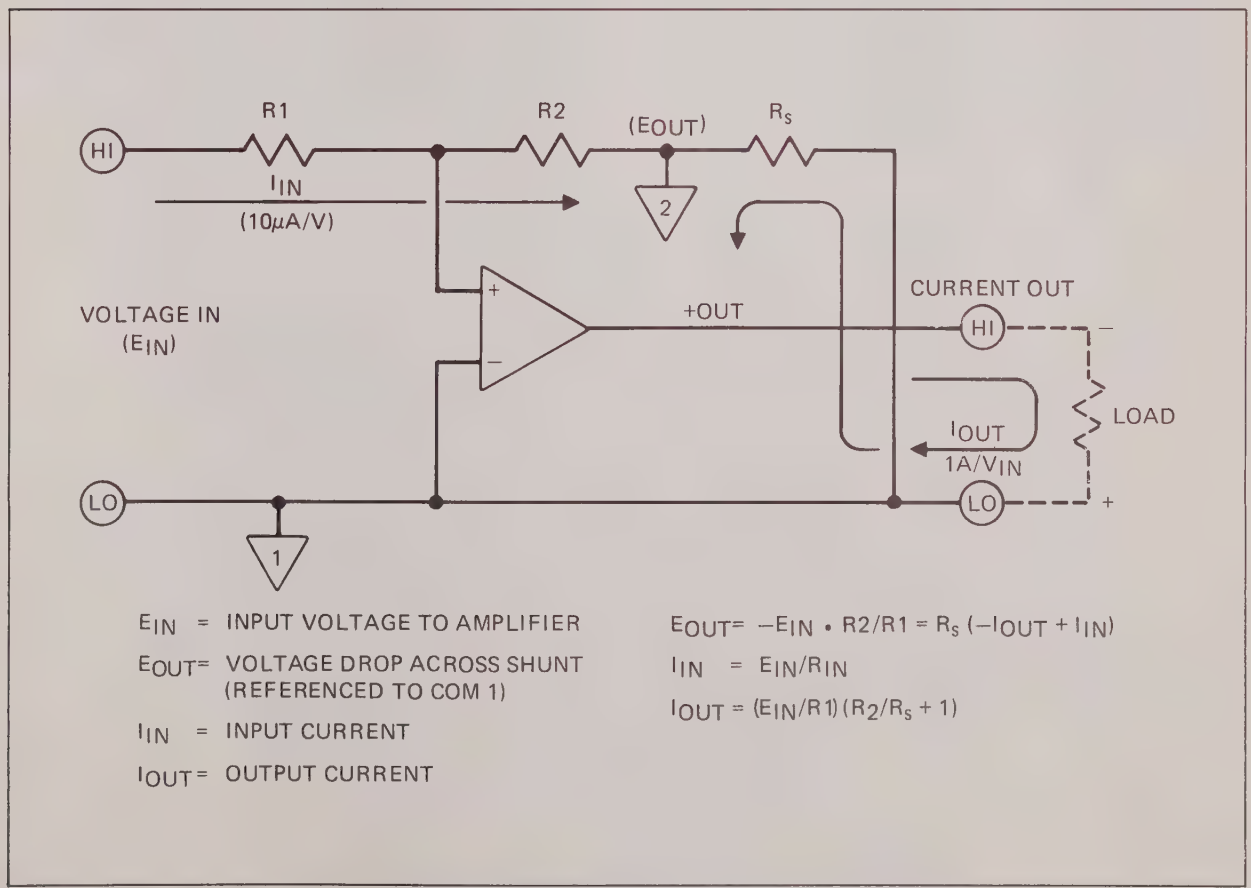


Figure 3-2. Transconductance Amplifier Simplified Circuit Diagram

3-18. Power Supply

3-19. The power supply, as shown in Figure 3-3, consists of the three major assemblies: A2 Transformer, A3 Cap Bus, and A4 Regulator. Its function is to transform line power into four sets of 5220A operating voltages. Each voltage set is isolated from the other, and three of the four are regulated. The three regulated voltage sets are: +15/–15V dc, +5V dc, and +5V ISO (isolated). The unregulated voltage set is +12/–12V dc.

3-20. The A2 Transformer Assembly consists of a series of three line-voltage selection switches, a power transformer, and appropriate secondary output fuses. Line power to the transformer passes through the front panel power switch (S4) and the line voltage selection switches before reaching the two primary windings. The setting of the line voltage switches (S1) connects the primary windings in either a parallel or a series configuration. Parallel connection is required for 115V ac operation and the series connection is used for 230V ac. Switches S2 and S3 allow selection of alternate primary winding tapes. They allow operation from 100, 110, 115, or 120V ac line voltages in the parallel configuration, or from 200, 220, 230, or 240V ac in the series configuration. The 115V ac ventilation fan is permanently connected to one of the primary windings, thus ensuring proper operation in either voltage configuration. Fuse protection for the power line is provided by an external fuse (F1) mounted on the rear panel. Supply overload protection for the regulated supplies is provided by secondary-winding fuses F4, F5, F6, and F7 located on the A2 Transformer Assembly.

3-21. The A3 Cap Bus is a high-current, unregulated, +12/–12V dc power supply designed to provide operating power to the output amplifier. It consists of two fuses, a full-wave rectifier, two bleeder resistors, and a bank of filter capacitors. Operating voltage is derived from a high-current center-tapped secondary winding of T1. It enters the A3 Cap Bus through overload fuses F2 and F3, and is full-wave rectified by diodes CR1 through CR4 to establish both positive and negative supply voltages. Filter capacitors, C1 through C8, filter the supply outputs. Bleeder resistors, R2 and R3, discharge the filter capacitors when line power is turned off.

3-22. The A4 Regulator is designed to convert the ac outputs from the three remaining secondary windings of T1 into three sets of isolated and regulated voltages: +5V dc, +15/–15V dc, and +5V dc ISO (isolated). Each voltage is produced using conventional regulating techniques. That is, it is rectified, filtered, regulated by a three-terminal regulator, and filtered again before being output. A fifth voltage, Line Mon (monitor), is also produced on the A4 Regulator. It is derived from the T1 windings used for the +15/–15V dc supply and is used to convey the line power status of the 5220A to the A10 Logic. The voltage is rectified by diodes CR8 and CR9, and clipped by zener VR1 before being output.

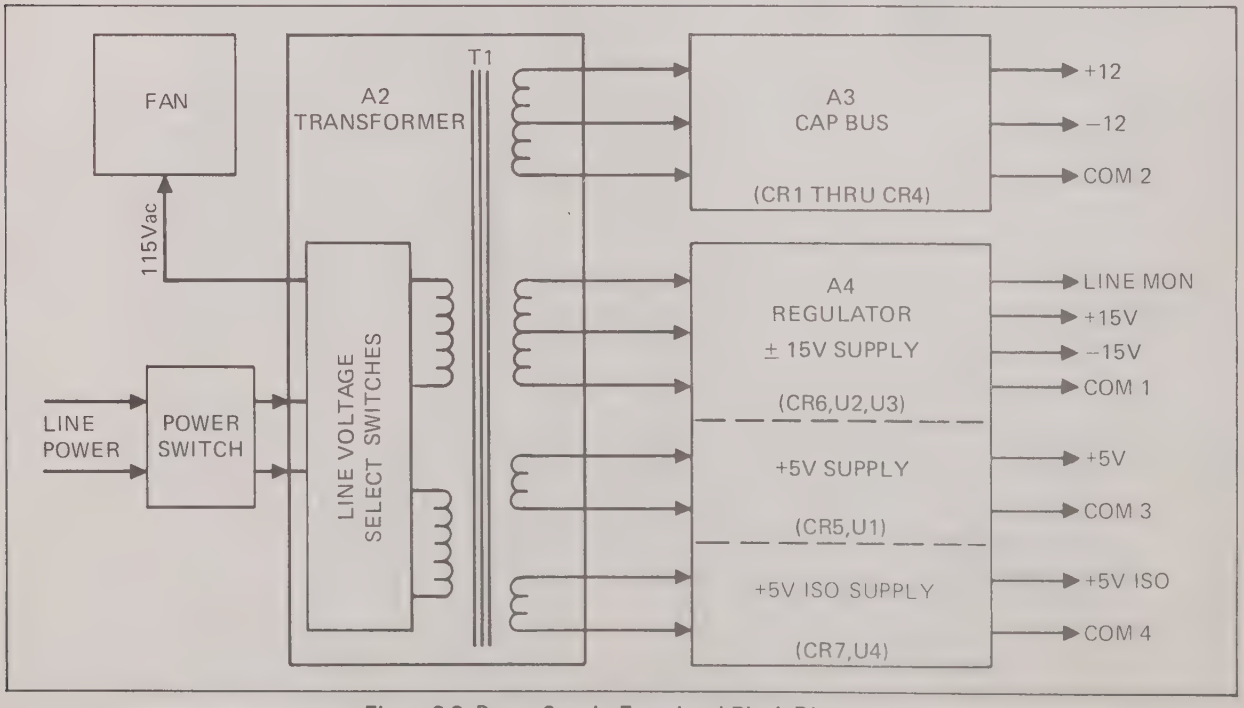


Figure 3-3. Power Supply Functional Block Diagram

3-23. A5 Preamplifier

3-24. The A5 Preamplifier, as shown in Figure 3-4, is a high-gain amplifier designed to accept a front/rear panel input signal and provide an amplified output to the A6 Driver stage of the transconductance amplifier. It consists of a high-gain differential amplifier with feedback resistors, front/rear input select relays, and turn-on/off control circuitry.

3-25. In operation, the input voltage source (front or rear), as selected by the A10 Logic, is connected through reed relay K1 (front) or K2 (rear) and input resistors R1, R3, and R13 to the inverting input of a differential transistor pair, Q2. The non-inverting input of Q2 is connected to COM 1 through parallel resistors R9 and R14. The resistance value approximates the value of R1 and R2 in parallel and, thereby balances the source impedance at the amplifier inputs. Balance is required to minimize apparent input offset voltage that may result from input currents. Diode CR3 and diode connected transistor Q3 are voltage clamps that prevent amplifier saturation on high input transients. The collectors of Q2A and Q2B drive the emitters of a pair of grounded base amplifiers formed by transistor array, U1. This holds the collectors of Q2 at a low and equal level to maintain low and equal collector-to-base leakage currents (ICER) at Q2. The actual collector voltage of Q2 is set by the temperature corrected divider formed by R4, R19, and the diode connected transistor U1C. Voltage variations at the collectors of U1A and U1B consititute the output of the differential amplifier, and are used as the input to op-amp, U2. Diodes CR4 and CR5 clamp the inputs to prevent U2 saturation when transient voltages appear. An ac feedback network, R15 and C7, fix the frequency response of the preamplifier to satisify the overall transconductance amplifier loop. Amplifier zero is established by the selected values of collector resistors R11 and R12, and the setting of the zero-adjust potentiometer, R6.

3-26. The turn-on/off control FETs, Q1 and Q4, operate as FET switches to control the overall gain of the A5 Preamplifier in both the standby and operate modes. Both FETs respond to the FET Drive 1 signal initiated (as T2) on the A10 Logic.

3-27. In the standby mode FET Drive 1 is near zero volts causing Q1 to turn on. FET Q1 completes the feedback loop between the output of U2 and the inverting input of Q2. This in effect reduces the gain of the A5 Preamplifier to zero. As a result, the output of the transconductance amplifier is forced to zero amperes. Photoresistor U3 is used to control the rate at which the input voltage is applied to the A5 Preamplifier when the 5220A is switched from standby to operate. This is necessary to prevent a step output which, if applied to an inductive load, would result in an overvoltage transient, forcing the 5220A back to standby. In standby both input select relays, K1 and K2, are open, capacitors, C3 and C12, are discharged, and the photoresistor U3 is a very high impedance with the LED drive removed. Thus, the A5 Preamplifier is effectively isolated from the input voltage.

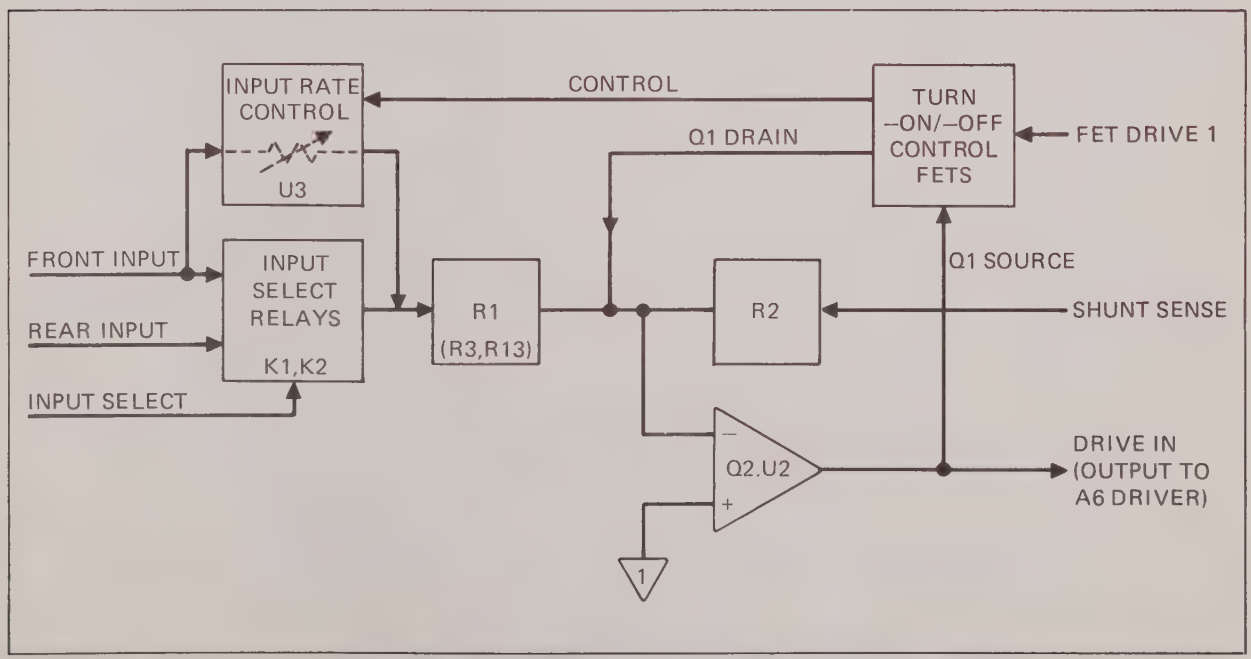


Figure 3-4. A5 Preamplifier Functional Block Diagram

3-28. In the operate mode FET Drive 1 is stepped to –15V dc causing FET Q1 to turn off. With Q1 off, the A5 Preamplifier returns to its high gain state with feedback established by resistors R1 and R2. If front input is selected, the Relay 1 drive signal is low and capacitor C12 begins charging. The increasing voltage across C12 increased the LED output from U3 which in turn, decreases the impedance of the photoresistor. Since the resistor is in parallel with the input contacts of the still open front-input relay K1, it acts as a variable input attenuator. In other words, the front input voltage is applied to the input of the A5 Preamplifier at a controlled rate and not as a step input. At the same time, a low Relay 1 drive signal is inverted by U4 causing C3 to charge through R24. When the charge reaches the threshold of the second inverter (U4) relay K1 is energized by a set of four parallel connected inverters. The charge time for C3 and C12 are designed to ensure that K1 closes after photoresistor U3 changes to a low impedance. When K1 closes, it places a short across the resistor in U3 and selects the front panel input voltage to drive the A5 Preamplifier. If the rear panel input signal is selected, a variable attenuator is not necessary because the signal from the remote 5100 rises at a controlled rate when switched from standby to operate.

3-29. A6 Driver

3-30. The A6 Driver, as shown in Figure 3-5, is a differential amplifier designed to accept its input from the A5 Preamplifier and to provide a differential drive signal to the A7 Output stage. The amplifier itself is of a descrete-component, complementary, push-pull design. Its features include: temperature compensated biasing for both itself and the A7 Output stage, an amplifier-disable circuit for standby operation, an an output-leakage current sink for standby operation.

3-31. The input section of the driver amplifier consists of a differential transistor pair, Q2 and Q3; a current regulator, Q4; and a common base driver, Q1, for the bias circuit. Transistor Q3 of the input pair receives the drive input from the A5 Preamplifier. The other input transistor, Q2, is driven by Shunt Sense 2, which provides negative feedback from the output current shunt to reduce distortion in the A7 Output stage. Current regulator Q4 regulates the emitter current of the differential pair, and provides isolation from variations in the –12V supply. Output from the differential pair is taken at the collector of Q3 by way of a common-base driver, Q1.

3-32. The bias section of the driver amplifier consists of resistors, R13 through R17, current regulator, CR1, and transistors, Q5 and Q107 (Q107 is physically located on the output amplifier's heat sink). Resistors R13 through R17 and current regulator CR1 form a series string which is driven by the output driver Q1 of the input amplifier. Regulator CR1 is at the end of the string and connected to –12V dc. This ensures a constant current of approximately 5.2 mA through the string. Transistors Q5 and Q107 are connected across resistors R14, R15 and R16, R17 as VBE multipliers to ensure that the voltage drop across the resistor string changes at a rate which will compensate for VBE temperature changes in the A6 Driver and A7 Output stages. Transistor Q5 senses ambient temperature changes while Q107 senses temperature changes due to power dissipation in the A7 Output. The temperature compensated voltage drop developed across the resistor string is used as a voltage source to set the quiescent bias for the remaining stages of the complementary A6 Driver and A7 Output. Variable resistor R13 is used to set the initial bias voltage.

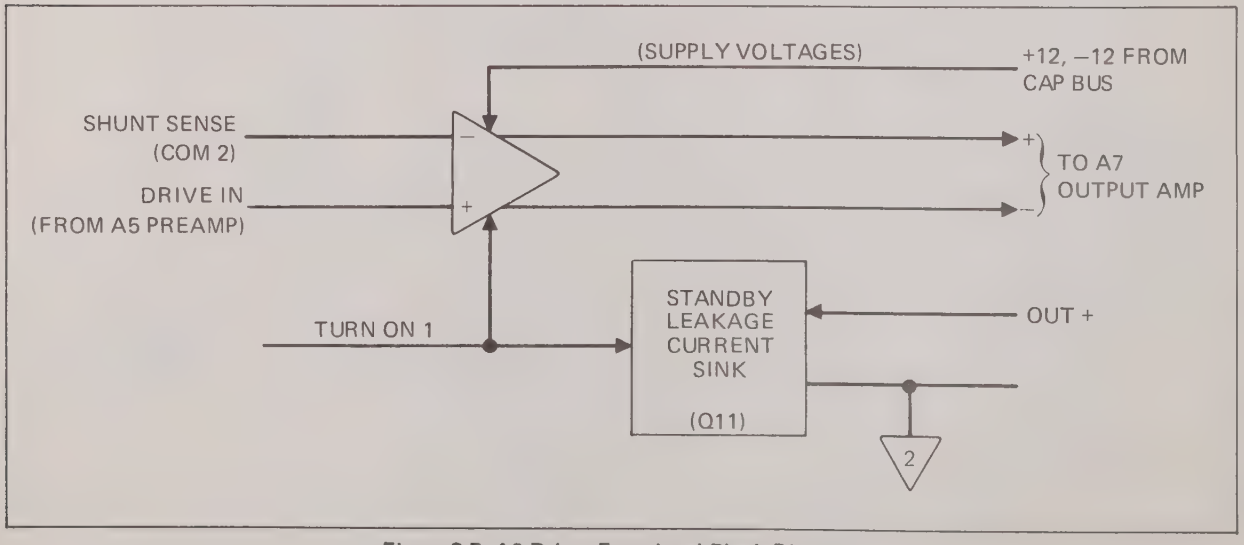


Figure 3-5. A6 Driver Functional Block Diagram

3-36. A7 Output

3-37. The A7 Output is a discrete-component, complementary-output, high-current amplifier which serves as the final output stage of the transconductance amplifier. See Figure 3-6. It consists of a pair of driver transistors, Q101 and Q102; two parallel pair(s) of output transistors, Q103, Q104 and Q105, Q106; a thermal sensing transistor, Q107; and a thermal overload switch S101. The differential output from the A6 Driver is applied to the bases of Q101 and Q102. These transistors are configured as emitter followers and provide the high current drive required by the output transistors. Collector resistors, R114 and R115, for Q101 and Q102 provide current limit protection under transient or fault conditions. Emitter resistors in the parallel output pairs prevent current hogging which would otherwise occur due to unequal VBE characteristics.

3-38. All transistors in the A7 Output, as well as the thermostatic switch, S101, are physically mounted on a common heat sink. The temperature of the heat sink is sensed by Q107 (part of the A6 Driver's bias network) and returned to the A6 Driver to provide bias compensation for the change in VBE with output-transistor temperature. (See A6 Driver description given earlier in this section of the manual.) Thermostatic switch S101 senses the temperature of the heat sink and provides an open contact output when an over-temperature condition is detected. The open output is sent to the A10 Logic which reacts by switching the 5220A to standby (over temperature may result from a loss or restriction of cooling airflow).

3-33. The characteristics of the VBE multipliers used in the bias section are stated in terms of Q5 in the following formulas:

$$VBE = [R14/R14 + R15]\ VCE$$

$$VCE = VBE\ [R14 + R15/R14]$$

3-34. The output section of the A6 Driver consists of transistors Q8, Q9, Q10, Q12, and associated components. Transistors Q8 and Q9 are arranged as complementary emitter followers which are both biased and driven by the bias section. This is followed by a common collector stage using Q10 and Q12. Overcurrent protection is provided in the stage by the 10 ohms resistors, R30 and R31, in the collector circuits. The differential output at the emitters of Q10 and Q12 is used as the drive input to the A7 Output stage.

3-35. In the standby mode of operation it is necessary to reduce the 5220A output to a zero-volt/zero-current condition. This is accomplished on the A6 Driver by two separate FET circuits. FETs Q6 and Q7 comprise the voltage shut-down circuit, and FET Q11 is the output current-sink. Both are enabled by a Turn-on I signal which is initiated (as TI) by the A10 Logic when the 5220A is switched to standby. When Q6 and Q7 are enabled (turned on) they remove the bias from the output stage of the A6 Driver, and thereby disable the bias to the A7 Output stage. In this state the output is essentially floating and is influenced only by leakage current that may be present in the output drivers. FET Q11 remedies the floating condition by effectively clamping the output to output common (COM 2).

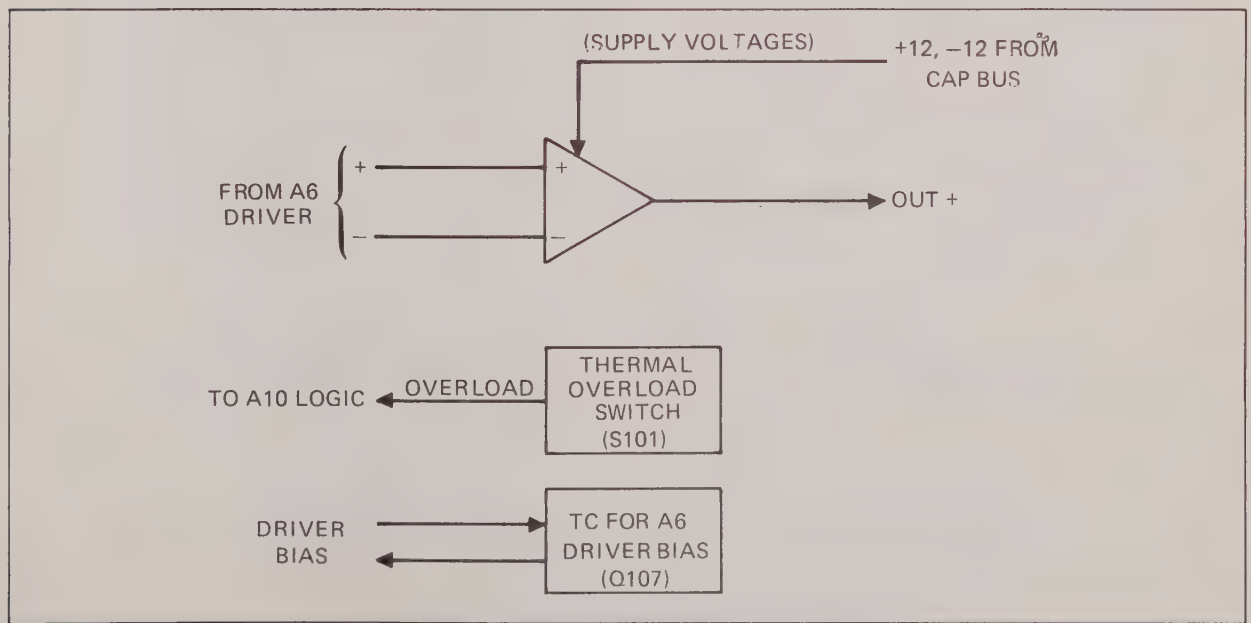


Figure 3-6. A7 Output Functional Block Diagram

3-39. A8 Analog Control

3-40. The A8 Analog Control Assembly, as shown in Figure 3-7, contains an overcompliance detector, an overcurrent detector, and two TTL-to-FET level shifters. The detection circuits are used to switch the 5220A to standby when an overcurrent or overcompliance condition occurs. The level shifters are driven by the A10 Logic to control the turn-on/off sequencing of the tranconductance amplifier.

3-41. The detection circuits are absolute value level detectors that provide a TTL output indication of the tranconductance amplifier's operating status; i.e., output voltage status and output current status. As long as both output voltage and current are within their specified operating range, both detectors will output a low logic level as a normal-operation status indication. However, if either or both the specified compliance voltage and/or the output current are exceeded, the appropriate detector will output a high logic level. Upon receipt of a high logic level from either detector the A10 Logic switches the 5220A to standby.

3-42. Each of the detectors is basically the same. They consist of an absolute value amplifier (full-wave rectifier), a level conditioner, a zener diode threshold detector, and a TTL buffered output stage. The absolute value amplifier is essentially a pair of operational amplifiers configured to provide an output voltage that is equal to the amplified positive absolute value of the input signal. The input to the compliance detector is connected to sense the voltage present at the output terminals (+OUT and COM 1). Similarly, the input to the overcurrent detector is connected to sense the voltage drop across the current shunt (COM 2 and COM 1). The result, in both cases, is a negative output level that is equal to the absolute value of the input signal. This level is sent to a level conditioner where it is filtered/integrated, inverted, and amplified. An adjustable gain control in the level conditioner's feedback loop provides for accurate adjustment of the trip level.

3-43. The output of the level conditioner feeds a series connected zener/resistor circuit with the resistor connected to logic common (COM 3). When the output of the level conditioner exceeds the zener voltage, the excess is dropped across the zener resistor. This voltage is monitored by a series-connected-pair of inverters which respond to the voltage drop as if it were a logic level. That is, voltages from 0 to an approximate 2 volt threshold are considered a low logic level. A high logic level is approximately 2 to 4.5 volts.

3-44. The TTL-to-FET level shifters are used to interface turn on/off commands TTL logic levels, T1 and T2, from the A10 Logic with the standby/operate control FETs in the transconductance amplifier. Both level shifters are identical in design. The input is designed to respond to voltage levels from +0.01 to +5.0V dc. Corresponding output levels to drive the FET gates are 0 to –15V dc.

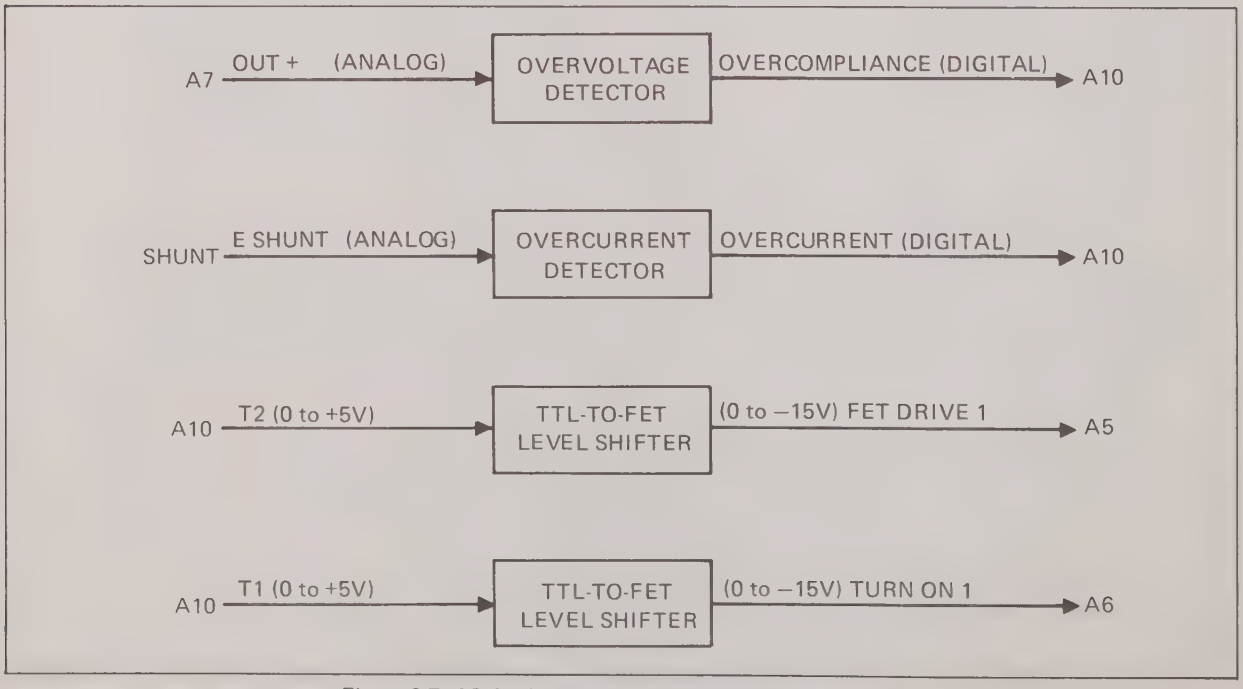


Figure 3-7. A8 Analog Control Simplified Block Diagram

3-45. A9 Front Panel

3-46. The A9 Front Panel Assembly contains the switches (with the exception of the power switch) and LEDs which comprise the 5220A controls and indicators. The switches are used to manually convey control information to the A10 Logic. This includes selection of: the local operating mode, standby/operate, and front/rear panel input. The LEDs display the current operating status of the 5220A as determined by the A10 Logic. Status conditions include: remote, local lockout (LLO), overcompliance, overcurrent, thermal cutout, front panel input, rear panel input, standby, and operate.

3-47. Electrically, the LEDs (anode end) and the switches (arm) are connected to a common +5V bus powered by the logic supply. A switch depression represents a +5V output to the A10 Logic. A series resistor connected to the anode end of each LED serves as a current limiter when the LED is lit. A low logic level from the A10 Logic lights the appropriate LEDs.

3-48. A10 Logic

3-49. The A10 Logic, as shown in Figure 3-8, is designed to process and control the timing and the input/output of all 5220A digital control data. Input data is received from the front panel controls, the A11 MIS Bus Interface, and the analog protection circuits of the transconductance amplifier. Output data provides timing and control signals to the amplifier (including its relays) and the front panel indicator LEDs.

3-50. RESET LOGIC

3-51. The reset logic consists of dual multivibrator U11, RC network R7/C2, OR gate U9-10, and inverter U3-10. Its function is to command the reset of the A10 Logic, and thus the 5220A, to an initial state when any one of the following events occur:

1. The 5220A is initially energized.
2. The +15/-15V dc power supply is interrupted.
3. Control is switched from remote to local.

3-52. When the 5220A is energized the +5V dc power supply rapidly rises to its +5 volts level to supply operating voltage to the A10 Logic Assembly. The voltage rise is integrated by RC network R7, C2. The slow rising voltage across C2 is used as a momentary low logic level to issue a reset command to all sections of the A10 Logic. Some sections are reset directly by the voltage across C2 while others are reset indirectly by the response of U11-10 to the voltage across C2.

3-53. Loss or interruption of the +15/-15V dc supply output causes the Line Mon(itor) input from the power supply to go low. Normally, the line monitor input is a clipped full-wave rectified 60 Hz waveform which is generated on the A4 Regulator Assembly. The negative-going edge is used as the trigger for monostable U11-7 which is timed to provide an output pulse of approximately 0.1 second. Since the output is longer than the time between triggers, it will remain active (Q low) as long as the Line Mon(itor) input is present. Under normal operating conditions the reset command is high at U9-10 and low at U3-10.

3-54. When the 5220A is switched from remote to local operation the local/remote logic triggers monostable U11-10 in the reset logic circuit. The result is a momentary positive-going pulse at the Ω output of U11-10. This in turn drives the complementary reset lines of U9-10 and U3-10.

3-55. The overall result of a reset command, regardless of how it is initiated, is to set the output commands of the A10 Logic to the states shown in Table 3-1. Essentially the unit is commanded to standby operation with front panel inputs selected. Remote and Local Lockout (LLO) commands are not affected by the reset command.

3-56. TIMING LOGIC

3-57. The timing logic controls the timing sequence used to switch the transconductance amplifier between the standby and operate modes. It consists of a bidirectional shift register U22, D-type flip-flops U17-1, and free running multivibrator U23. The multivibrator runs at a frequency of 100 Hz (10 ms period) and serves as the clock for both the flip-flop and the shift register. Flip-flop U17-1 responds to the reset command (reset input) and the standby/operate commands (D-input) to select the shift register's control mode; i.e., shift left or shift right. The shift register's four outputs are sequenced low in the shift-left mode and high in the shift-right mode. With all outputs low the transconductance amplifier is set to standby. The amplifier is operational when all outputs are high.

3-58. The shift-left mode is selected when flip-flop U17-1 drives the register's S0 input low and its S1 input high. (This occurs as the result of a standby or reset command.) In this mode, the register sequentially propogates the low input at U22-7 through the register causing its four outputs (QA, QB, QC, and QD) to be sequentially driven low. Since the register shifts at the rate of the 100 Hz clock, the outputs are sequenced at intervals of 10 ms. At the end of four clock pulses all four outputs are low (standby), and will remain low until the register is commanded to shift right.

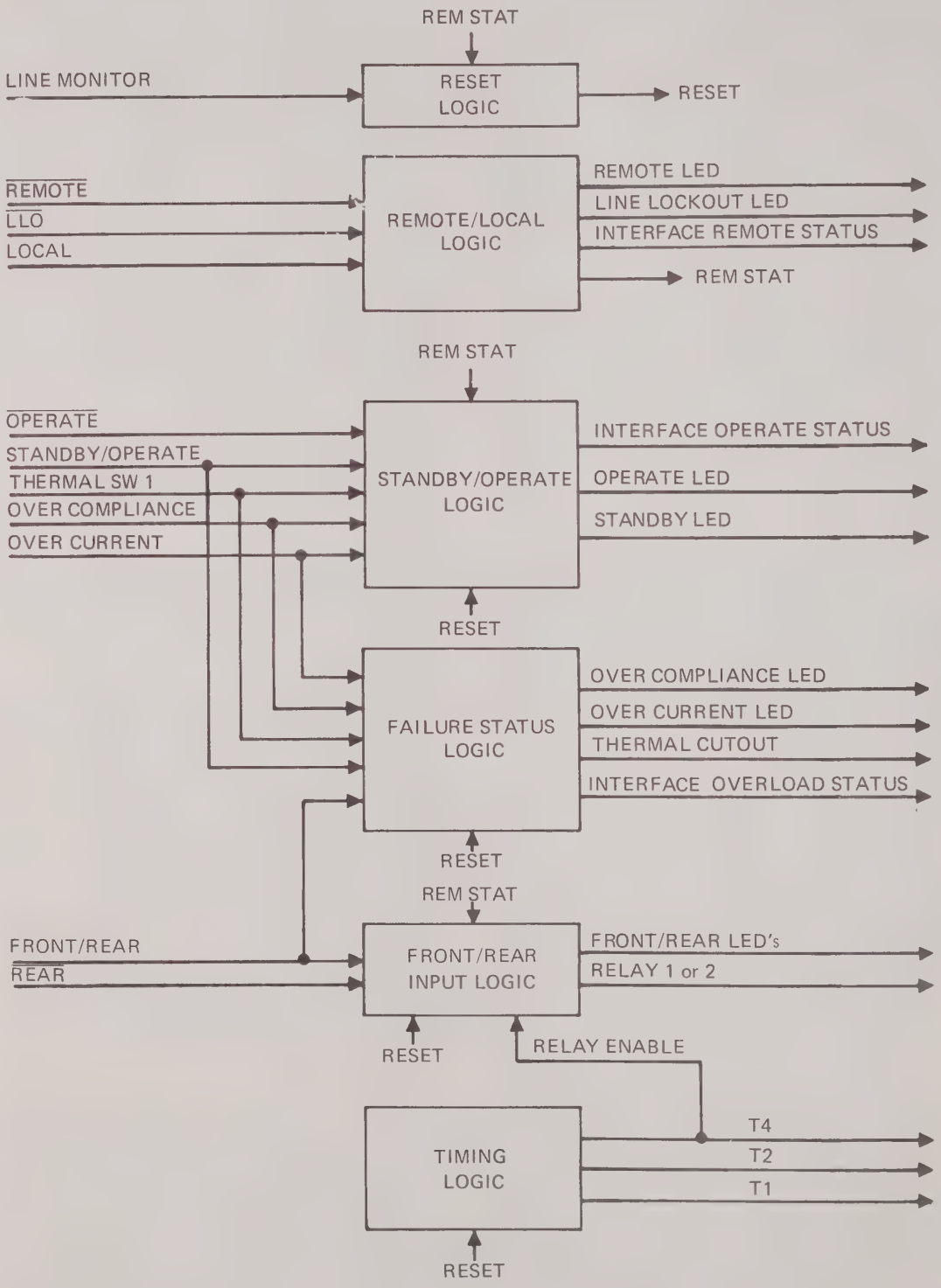


Figure 3-8. A10 Logic Simplified Block Diagram

Table 3-1. Effect of Reset Command on A10 Logic and A9 Front Panel

SIGNAL NAME	LOGIC STATE	FRONT PANEL LED STATUS
Interface Operate Status	Low	None
Operate LED	High	OPER LED off
Standby LED	Low	STDBY LED on
T1, T2, and T4	Low	None
Relay 1	High	None
Relay 2	High	None
Front Panel Input LED	Low	FRONT LED on
Rear Panel Input LED	High	FRONT LED off
Overcompliance LED	High	OVERCOMPLIANCE LED off
Overcurrent LED	High	OVERCURRENT LED off
Thermal Cutout LED	High	THERMAL CUTOFF LED off
Interface Overload Status	Low	None

3-59. The shift-right mode is selected when flip-flop U17-1 responds to an operate command (D-input low) and drives the register's S0 input high and the S1 input low. This results in the high input at U22-2 being sequentially propogated through the register and its four outputs (QD, QC, QB, and QA) being driven high (operate).

3-60. The outputs of the shift register are used as control signals to sequence the turn-on and turn-off of the transconductance amplifier. They are designated T1, T2, and T4 (T3 is not used) and their sequence is shown in Figure 3-9. The control function of each of the signals is as follows:

1. T1 turns the A6 Driver on and off.
2. T2 turns the A5 Preamplifier on and off.
3. T4 enables/disables the selected front/rear input relay (K1 or K2) on the A5 Preamplifier.

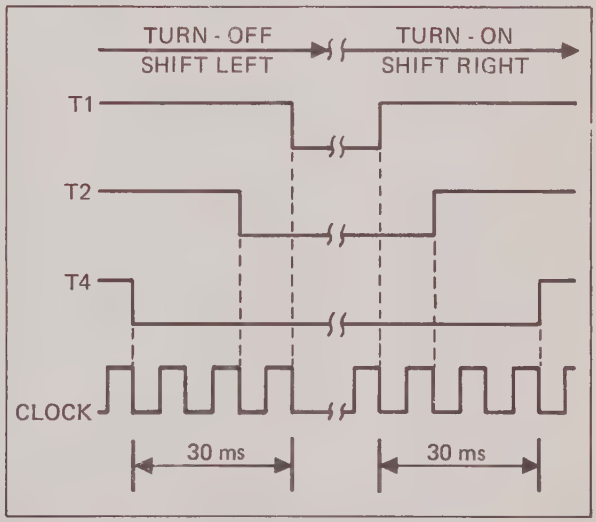


Figure 3-9. Timing Sequence

3-61. STANDBY/OPERATE LOGIC

3-62. The standby/operate logic consists of optical isolators U1 and U5, monostable U8-7, D-type flip-flop U10-9, and a series of supporting logic gates and buffers. Its function is twofold. One, it responds to reset and external inputs to command the state of the timing logic, shift left (standby mode), or shift right (operate). Two, it drives the front-panel STANDBY/OPERATE LEDs and provides the A11 MIS Bus Interface (remote interface) with an Interface Operate Status (Standby/Operate) signal. Flip-flop U10-9 is used to store the commanded mode (standby or operate) and to provide the necessary commands to the shift register (in the timing logic) and the LED/status drivers. Optical isolators U1 and U5 are used to electrically isolate remote control signals to and from the A11 MIS Bus Interface from the A10 Logic.

3-63. Standby/operate commands occur in the form of Reset, Standby/Operate, not Operate, Sw(itch) 1, Overcompliance, and Overcurrent. Reset is an onboard command from the reset logic. It sets the 5220A to standby by commanding U10-9 to the clear state (Ω low). Standby/Operate is received in the form of a +5V (high) input each time the front-panel STANDBY/OPERATE switch is pressed. If the 5220A is in the local control mode, each press of the switch will clock flip-flop U10-9 to its alternate state. The result is an alternate selection of either the standby or the operate mode, as indicated by the front-panel STANDBY and OPERATE LEDs. A similar command, Interface Operate Status (also derived from the state of U10-9), is issued to the A11 MIS Bus Interface; low indicates standby, high indicates operate. The not Operate signal is received from the A11 MIS Bus Interface and is effective only when the 5220A is in the

remote control mode. In the high state, the signal clears flip-flop U10-9 to invoke the standby mode. When not Operate goes low it presets flip-flop U10-9 (by way of U8-7) to invoke the operate mode. Overload signals received at the standby/operate logic include; Thermal Sw(itch) 1, Overcompliance, and Overcurrent. When any one of these signals goes high, flip-flop U10-9 is cleared to the standby state.

3-64. LOCAL/REMOTE LOGIC

3-65. The local/remote logic consists of optical isolators U4 and U20-8, monostable U8-9, D-type flip-flop U7, and a series of supporting logic gates and buffers. Its function is to enable selection of the desired control mode (local or remote) and to provide the drive for the appropriate front panel and A11 MIS Bus Interface status indicators. These include: LLO (Local Lockout) LED, Remote LED, and Interface Remote Status. Flip-flop U7 is used to store the commanded mode (local or remote) and to provide the necessary commands to the onboard logic and the LED/status drivers. Optical isolators U4 and U20-8 electrically isolate remote control signals to and from the A11 MIS Bus Interface from the A10 Logic.

3-66. Local/remote commands are received in the form of Local, not Remote, and not LLO (Local Lockout). Local occurs as a momentary +5V (high) input each time the front panel LOCAL switch is pressed. If the 5220A is in the remote control mode and Local Lockout is not commanded (high) pressing the front panel LOCAL switch will initiate a 1 μs pulse from monostable U8-9. This pulse clears flip-flop U7, which in turn, commands the A10 Logic to the local mode (Rem Stat low). As a result, the Remote LED and LLO LED signals are high, Interface Remote Status is low. However, if not LLO is low when the LOCAL switch is pressed, monostable U8-9 will be held in the reset state and flip-flop U7 will not be cleared. Thus, the A10 Logic is effectively locked into the remote mode until not LLO is returned high.

3-67. The not Remote signal is received from the A11 MIS Bus Interface and is used to remotely command the A10 Logic to the remote control mode. When the signal goes low it is coupled across optical isolator U4 to the clock input of D-type flip-flop U7. This sets the Q output of U7 high to select the remote control mode (Rem Stat high). As a result, the Remote LED signal goes low to light the REMOTE LED and the Interface Remote Status output goes high.

3-68. When the 5220A is commanded to the remote mode the front-panel STANDBY/OPERATE and FRONT/REAR switches are disabled and the corresponding remote inputs are enabled. Similarly, if LLO is remotely enabled, the LOCAL pushbutton is disabled.

3-69. FRONT/REAR INPUT LOGIC

3-70. The front/rear input logic is used to command the front/rear input relays on the A5 Preamplifier and to drive the appropriate FRONT/REAR LED on the front panel. When the A10 Logic is in the local mode, Front/Rear commands are received from the front panel pushbutton. Each switch depression is received as a +5V (high) level which is used to clock alternate states on D-type flip-flop U10-5. The FRONT LED and relay K1 are commanded when the Q output of U10-5 is low. When the A10 Logic is in the remote mode the not Rear input signal is used to command the front/rear input relays. Front input is selected when not Rear is high. Actual opening/closing of the relays is enabled at time T4 of the timing logic.

3-71. FAILURE STATUS LOGIC

3-72. The failure status logic consists of three D-type flip-flop (U16-1, U16-13, and U17-13) and their associated logic gates and drivers. Its function is to store failure conditions detected by other parts of the A10 Logic and to drive the front panel STATUS indicators. An optical isolator is also included for providing an Interface Overload Status signal to the A11 MIS Bus Interface. Front panel status indicators comprise three LEDs: OVERCOMPLIANCE, OVERCURRENT, and THERMAL CUTOUT. When any one of these LEDs is lit, Interface Overload Status is driven high.

3-73. The inputs to the D-type flip-flop are connected to respond to three commands: reset, clock, and set. The reset and clock inputs are used to set the Q outputs low, and thereby remove the drive from the front panel STATUS LEDs. The three reset inputs are connected in parallel and are commanded when the 5220A is initially energized and when it is remotely commanded from standby to operate. The clock inputs are also connected in parallel. They respond to a high input which transfers the low D-input to the Q output. The clock is driven high under the following conditions:

1. When the STDBY/OPR pushbutton is pressed.
2. When the FRONT/REAR pushbutton is pressed.
3. When an onboard reset is initiated.

3-74. The set-inputs to the flip-flops in the failure status logic are used to set the Q outputs high when a failure status is detected. This causes the corresponding STATUS LED to be lit and the Interface Overload Status signal to go high. Each flip-flop responds to one of the failure signals issued by the transconductance amplifier. They are:

1. Thermal Sw(itch) 1
2. Overcompliance
3. Overcurrent

3-75. A11 MIS Bus Interface

3-76. The A11 MIS Bus Interface, as shown in Figure 3-10, is a remote control interface that allows the 5220A to operate as an extension of a 5100 Series Calibrator equipped with a Model Y5000 Interface. An accessory cable is available for use with the Y5000 to complete the necessary connections between the Y5000 and the A11 MIS Bus Interface.

3-77. Functionally, the A11 MIS Bus Interface (hereafter referred to as the MIS I/F) performs three basic functions: receives and stores digital control data from a remote control source (Y5000), interfaces 5220A status signals to the Y5000, and provides a connecting path between the remote analog input signal (Aux Out) and the rear-input connections on the A5 Preamplifier. Operating power for the assembly is derived from the +5V ISO (isolated) power supply.

3-78. Control data is received at the MIS I/F via the data bus as a 4-bit parallel word. When the 5100 Series Calibrator places the correct address on the address bus (BC0, BC3, and BC6 high), the write data logic responds by pulling the not ACK(nowledge) line low and clocking the control data word into the data register, U1. The not ACK signal is sent to the 5100 to acknowledge the receipt of a valid address. The register outputs are buffered and inverted by U6 before being used as remote programming inputs to the A10 Logic PCB (i.e., not Remote, not Operate, not LLO, and not Rear). At the same time that the address is acknowledged, an RS flip-flop in the write data logic is set.

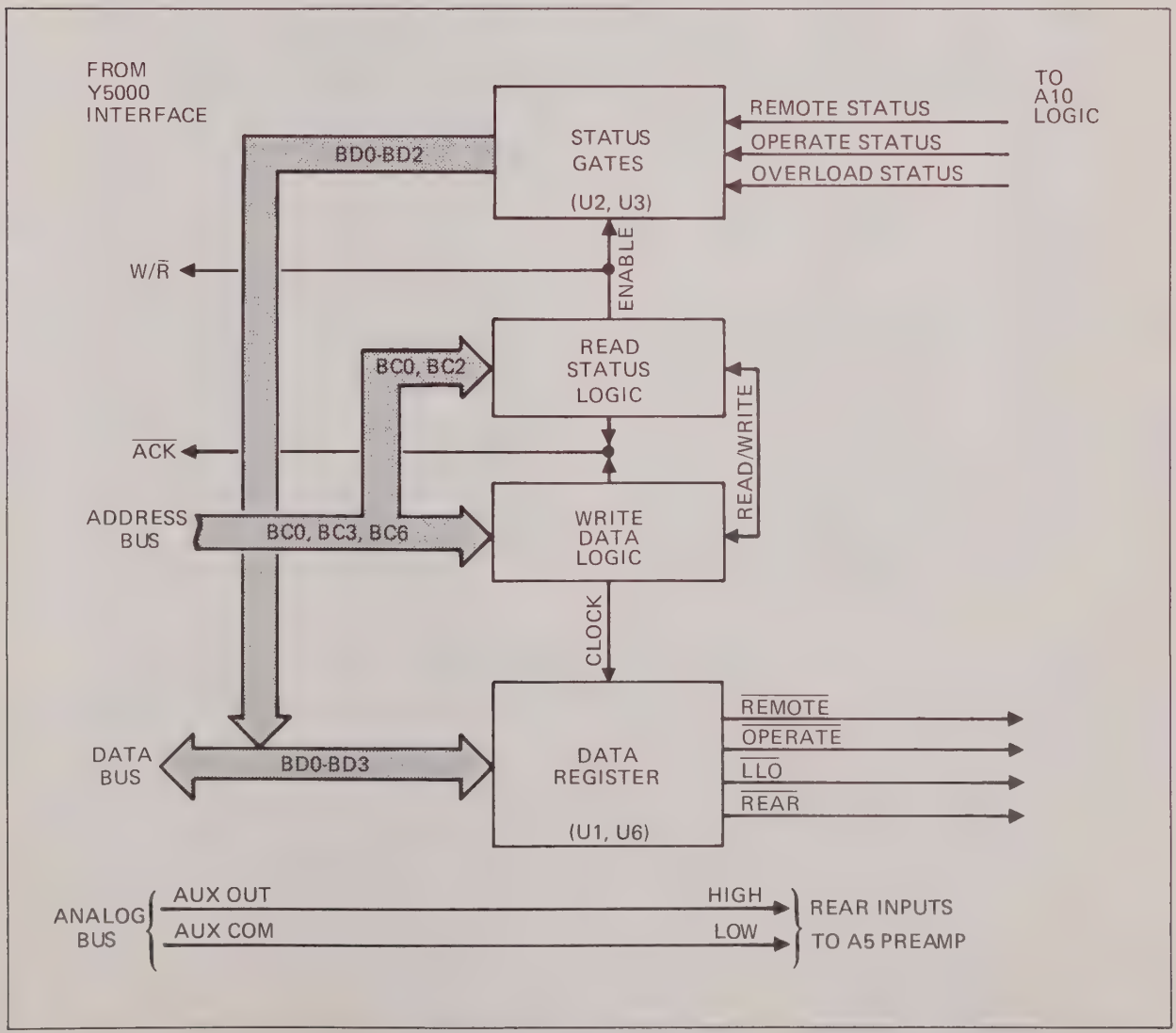


Figure 3-10. A11 MIS Bus Interface

3-79. The function of the RS flip-flop is to prevent two successive status read inputs to the 5220A. The flip-flop is set when a high is present on inputs BC0, BC3, and BC6. This results in a low output from U5-8 and a high output from U4-6. In this state, gate U5-8 is enabled so that a status read can take place when BC0 and BC2 go high. Status read causes the write/read (W/not R) line to go low for the duration of the BC0 and BC2 inputs. At the end of status read, the RS flop-flop is reset, closing the W/not R gate (U5-8) until it is reopened by another programming input. This process is repeated every 16 ms because the 5100 Series Calibrator refreshes the programming input to the 5220A at this rate.

3-80. Status information is received at the MIS I/F as 3-bits of parallel data (Remote Status, Operate Status, and Overload Status) from the A10 Logic. When the 5100 Series Calibrator places the correct address on the Address Bus (BC0 and BC2 high), the read status logic responds by pulling the not ACK line low and gating the three status bits onto the data bus. The not ACK signal is sent to the 5100 to acknowledge the receipt of a valid address. At the same time the RS flip-flop in the read status logic is reset. This causes a read command (W/not R low) to be sent to the 5100 so that it can read the data bus. The acknowledge output and the W/not R line will return high when the status address code is removed from the Address Bus.

3-81. The analog output from the 5100 is passed through the Y5000 and the MIS I/F by way of a 2-wire (high, low) Analog Bus. The signal is routed directly from the MIS I/F to the rear input connections on the A5 Preamplifier.

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NO PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenace information for the Model 5220A Transconductance Amplifier. The material is presented under the categories of shipping information, general maintenance, performance test, calibration adjustments, and troubleshooting. The performance test is recommended as an acceptance test when the unit is first received, and later as a calibration procedure to verify the 180-day specifications. Table 4-1 lists the equipment required for both the performance test and calibration adjustments. If a recommended model is not available, an equivalent instrument meeting the required characteristics can be substituted.

4-3. SERVICE INFORMATION

4-4. The 5220A is warranted for a period of 1-year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before work is begun on instruments that are beyond the warranty period.

Table 4-1. Required Test Equipment

EQUIPMENT TYPE	REQUIRED SPECIFICATIONS	RECOMMENDED TYPE
DC Voltage Calibrator	0 to 20V dc ±0.002% ,005%	Fluke Model ~~332B~~ EDC 1030
AC Voltage Calibrator	100 Hz to 5 kHz ±0.002%	Fluke Model 5200A 5101B
Digital Voltmeter	0 to 20V dc ±0.002%, Resolution 1 μV ,009%	Fluke Model ~~8502A~~ KEITH 197
True RMS Voltmeter	0 to 20V dc ±0.05%, 30 Hz to 10 kHz ,35%	Fluke Model 931B " "
Precision Shunt	0.01Ω ±.01% dc, 0.035% ac to 5 kHz	Fluke Model Y5020
Load Resistor	0.1Ω ±3%, 50 watts	Dale RH-50
Load Resistor	1Ω ±5%, 5 watts	Dale RH-~~5~~10
Distortion Analyzer	Frequency range - 100 Hz - 5 kHz	Sound Technology HP 3[illegible] Model 1700A
Autotransformer	Nominal line voltage ±10%, 500 watts	General Radio Variac

4-6. GENERAL MAINTENANCE

4-7. Cleaning

4-8. Clean the 5220A periodically to remove dust, grease, and other contamination. Use the following procedure:

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.

2. Clean the surface of the pcbs using clean, dry air at low pressure (≤20 psi). If grease is encountered, spray with Freon T.F. Degreaser and remove grime with dry, low-pressure air.

4-9. Air Filter Maintenance

4-10. Periodically inspect the air filter on the rear panel for dirt and contaminants. If cleaning is required, use the following procedure:

1. Disconnect the 5220A from line power.

2. Remove the two screws from the filter housing and gently pull the filter assembly from the unit.

3. Clean the filter using either low-pressure air or a mild solution of detergent and water.

4. Dry (if necessary) and reinstall the filter.

4-11. Access Information

4-12. The 5220A is a modular instrument that can be easily disassembled by sections. Procedures for section disassembly are given in the following paragraphs. Some procedures require the completion of previous procedures in the disassembly process. When this occurs, the previous prodedure will be referenced, but not repeated.

WARNING

TO AVOID ELECTRICAL SHOCK HAZARD, DISCONNECT THE 5220A FROM LINE POWER BEFORE ATTEMPTING ANY OF THE FOLLOWING DISASSEMBLY PROCEDURES.

4-13. Reassembly of the instrument is accomplished by logically reversing the disassembly procedure. Before installing the top covers on the unit, make a visual comparison with Figure 4-1 to ensure the presence of all assemblies, jumpers, and fuses.

CAUTION

To prevent component damage, observe static awareness precautions during instrument disassembly/assembly. Refer to the yellow insert sheet following Section 1.

4-14. INTERNAL COMPONENTS/ASSEMBLIES

4-15. All internal switches, fuses, and calibration adjustments can be accessed by removing the top cover and the large inner cover from the 5220A. The location of each of the applicable components is shown in Figure 4-1. Procedures for setting, replacing, and/or adjusting these components are given later in this section of the manual.

4-16. FRONT PANEL REMOVAL

4-17. There are no electrical components physically mounted on the front panel of the 5220A. Use the following procedure to remove the front panel:

1. Remove the top and bottom covers from the 5220A.

2. Stand the instrument on its rear handles. Use a solid work surface.

3. Locate the two tabs at the rear of each front handle and remove the tab screws (4 total).

4. Lift the front panel from the chassis.

4-18. A9 FRONT PANEL PCB REMOVAL

4-19. Use the following procedure to access and remove the A9 Front Panel PCB Assembly:

1. Remove the front panel.

2. Remove the two screws from the top of the A9 Front Panel PCB Assembly.

3. Pull the pcb from its connector (J10).

4-20. A2 TRANSFORMER ASSEMBLY REMOVAL

4-21. Use the following procedure to remove the A2 Transformer Assembly from the 5220A:

1. Remove the top cover from the 5220A.

2. Remove the large inner cover.

3. Locate and remove the two screws that hold the A2 Transformer Assembly to the chassis side.

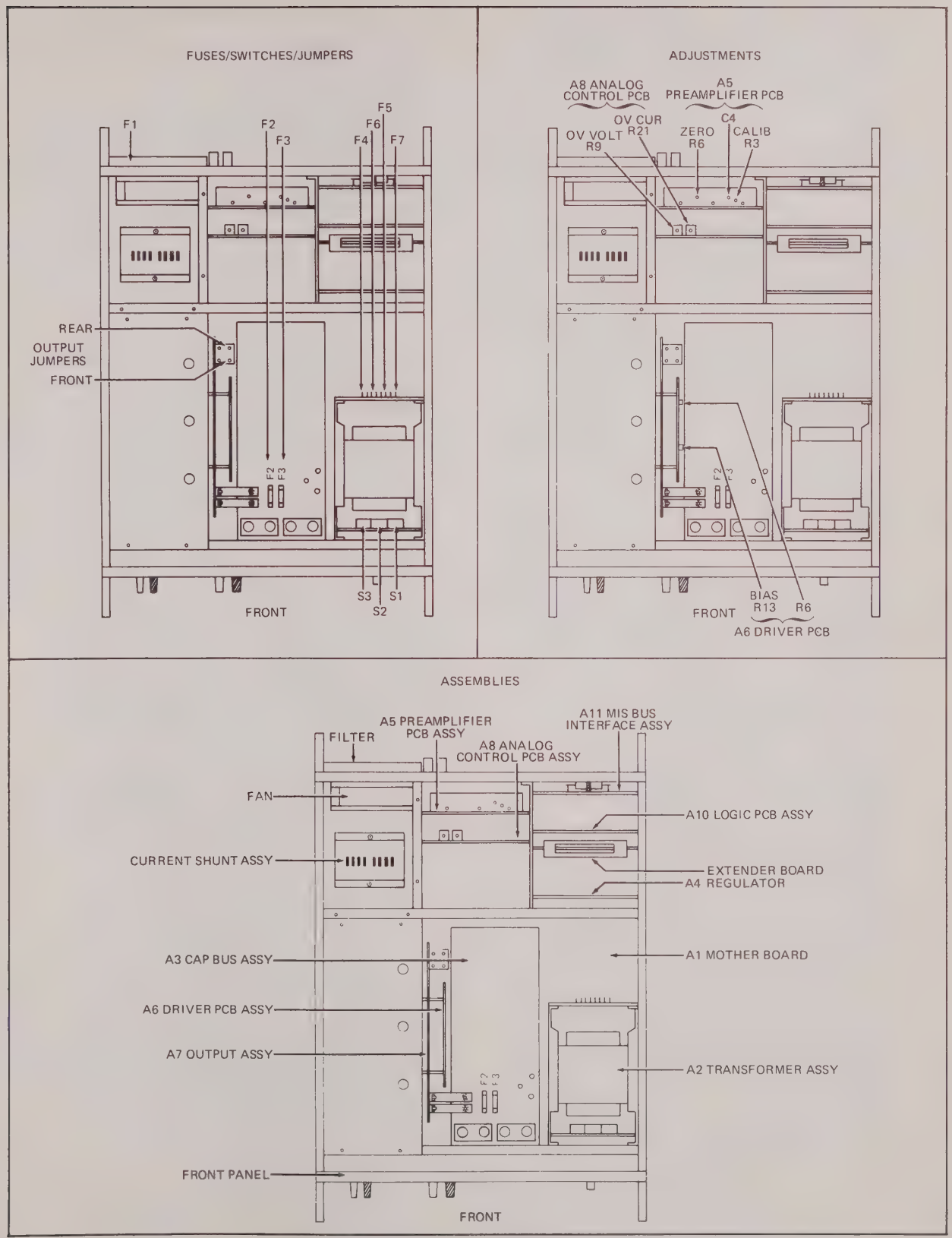


Figure 4-1. Internal Component/Assembly Locations

4. Remove the two screws that hold the A2 Transformer Assembly to the motherboard. These screws are located on the bottom right-side of the transformer assembly (as viewed from the top rear of the 5220A).

5. Remove the two hex screws that hold the top front of the transformer assembly to the 5220A front bulkhead.

6. Disconnect the three high-current transformer leads at the A3 Cap Bus Assembly. Lug nuts hold the leads in place.

NOTE

When reassembling, the clear colored lead (center top) must be connected to the terminal marked T. Connect one black lead to terminal S and the other to terminal F.

7. Carefully lift the A2 Transformer Assembly from the 5220A.

4-22. A6 DRIVER AND A7 OUTPUT ASSEMBLY REMOVAL

4-23. The A6 Driver and A7 Output PCB Assemblies comprise a plug-in assembly referred to in this procedure as the A6 Driver/A7 Output. Use the following procedure to remove the A6 Driver/A7 Output:

1. Remove the top cover from the 5220A.

2. Remove the large inner cover.

3. Remove the four screws from the sheet-metal portion of the A7 Output Assembly.

4. Remove the lug nuts holding the +12 and -12V bus straps to the A3 Cap Bus.

5. Remove the front/rear output selection screws (jumpers).

6. Lift the A6 Driver/A7 Output from the chassis.

4-24. A3 CAP BUS REMOVAL

4-25. To remove the A3 Cap Bus from the 5220A use the following procedure:

1. Remove the top and bottom covers from the 5220A.

2. Remove the top inner cover.

3. Remove both the front panel and the A9 Front Panel PCB Assembly.

4. Remove the A6 Driver/A7 Output Assembly.

5. Disconnect the transformer leads at the A3 Cap Bus.

6. Remove the two screws that secure the A3 Cap Bus ground strap to the motherboard.

7. Remove the nine screws holding the A3 Cap Bus to the front panel bulkhead.

8. On the A3 Cap Bus locate and the remove the two large-head screws located to the side of resistors R2 and R5.

CAUTION

When these screws are installed they should be snug with the pcb. However, they should not cause the pcb to bow.

9. Lift the A3 Cap Bus from the chassis.

NOTE

A heatsink compound has been applied to the diode-end of the A3 Cap Bus. Do not wipe off or otherwise remove this compound.

4-26. A12 SHUNT ASSEMBLY REMOVAL

4-27. Use the following procedure to remove the A12 Shunt Assembly:

1. Remove the top cover from the 5220A.

2. Remove both the large and small inner covers.

3. Remove the A8 Analog Control PCB Assembly from its connectors (J40).

4. Unplug the red-/black-lead connector next to J50 on the motherboard.

5. Locate the A12 Shunt Assembly (just in front of the fan) and remove the two screws at the base of the assembly.

6. Carefully pull the A12 Shunt Assembly straight up while feeding the red-/black-leads under the bulkhead. When the leads are free, remove the A12 Shunt Assembly from the chassis.

NOTE

When reinstalling the shunt make sure that the red-/black-leads are plugged into the motherboard; red lead to pin R, black lead to pin B.

4-28. Fuse Replacement

4-29. AC LINE FUSE

4-30. The ac line fuse is accessible by way of a rear-panel fuse holder located to the left of the input power connector. If fuse replacement is required, disconnect the 5220A from line power and remove the fuse cap and fuse (twist the fuse cap ccw using a screwdriver). Select and install a replacement fuse whose rating is compatible with the local line voltage.

1. 100 to 120V ac use fuse type MDA 3A

2. 220 to 240V ac use fuse type MDX 1.5A

4-31. POWER SUPPLY FUSES

4-32. There are six fuses located inside of the 5220A. Each is used to fuse one of the secondary windings of the power transformer. Four of the fuses are located on the A2 Transformer Assembly, and two are on the A3 Cap Bus. Their locations (F2 through F7) are shown in Figure 4-1. Use the following procedure when replacement is necessary:

1. Disconnect the 5220A from line power.

2. Remove the top and large inner covers from the 5220A.

3. With reference to Figure 4-1, locate and inspect fuses F2 through F7. The fuses are installed in fuse clips and can be pulled out using your fingers.

4. Replace defective fuses with the appropriate type and rating:

   a. F2 and F3 are AGC 20A fuses.

   b. F4 through F7 are MDL 1/2A fuses.

4-33. Line Voltage Selection

4-34. The 5220A is set at the factory to operate at a line voltage of either 115 or 230V ac ±10%, 40 to 60 Hz. The selected voltage is identified on a rear panel decal. If your local line voltage is not within this preset range, a suitable range may be selected by setting a series of three switches (S1, S2, S3) on the A2 Transformer Assembly. Figure 4-2 shows the switch locations as well as the switch settings for eight different line voltages. Use the following procedure to set the line voltage switches:

1. Disconnect the 5220A from line power.

2. Remove both the top cover and the large inner cover from the 5220A.

3. With reference to Figure 4-2, locate and set switches S1, S2, and S3 to the positions indicated for the desired line voltage.

4. Reinstall the top and inner covers.

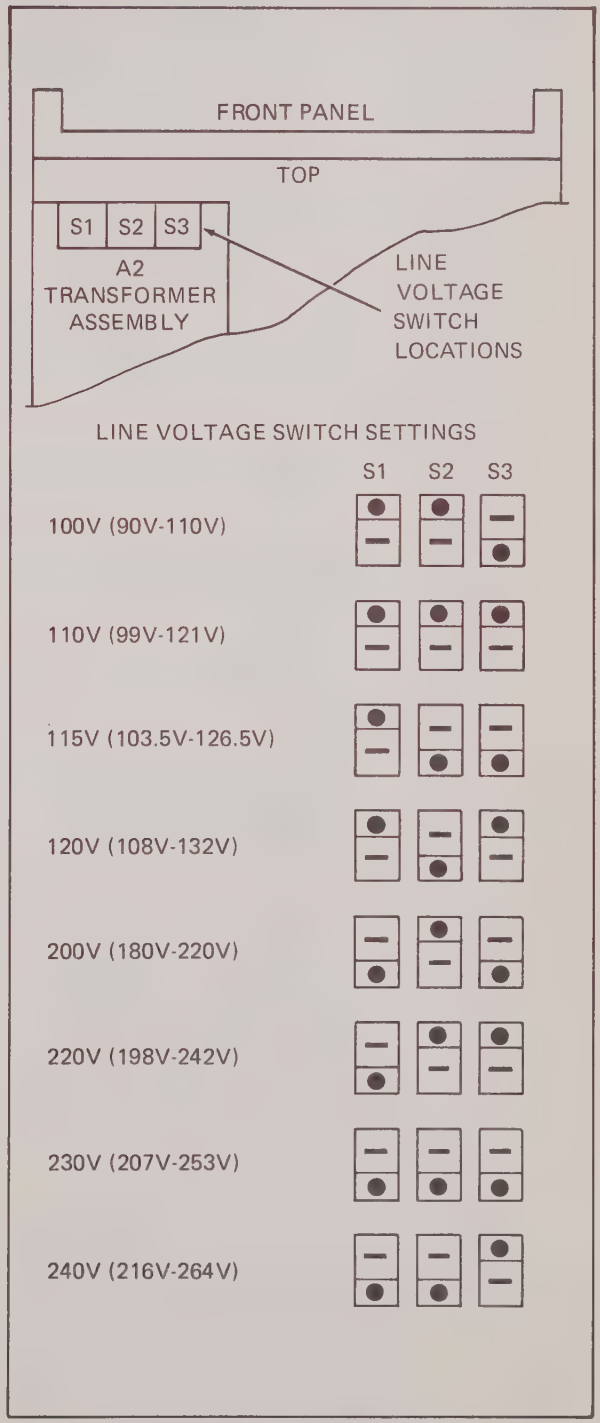


Figure 4-2. Line Voltage Selection

4-35. Output Terminal Selection, Front/Rear

4-36. Either the front or rear output terminals (but not both simultaneously) may be selected to provide the current output connections. The active terminals are determined by the position of a pair of screws which serve as output jumpers. See Figure 4-1 for the output jumper (screw) locations. Installing the screws in the two holes marked FRONT enables the front CURRENT OUTPUT terminals. Similarly, installing the screws in the two holes marked REAR enables the rear output terminals. Use the following procedure to position the screws:

CAUTION

To ensure proper instrument operation make sure that both screws are installed and that they are both in either the FRONT or REAR locations.

1. Disconnect the 5220A from line power.

2. Remove both the top and large inner covers from the 5220A.

3. Locate the output jumper screws as shown in Figure 4-1.

4. Install and secure the screws in the two FRONT or REAR holes, as desired.

5. Reinstall the top and inner covers.

4-37. Service Tools

4-38. The 5220A comes equipped with an extender board for servicing other 5220A pcb assemblies. A storage slot for the board is provided in the 5220A. See Figure 4-1 for the storage location.

4-39. PERFORMANCE TEST

4-40. The following paragraphs comprise a performance verification test which compares the instrument's performance to the specifications given in Section 1 of this manual. The test is recommended as an acceptance test when the unit is first received, and later as a calibration procedure to verify instrument accuracy at the scheduled calibration periods. It is also useful as an aid in troubleshooting.

4-41. Test equipment required for the performance test is listed earlier in Table 4-1. If the recommended equipment is not available, comparable instruments with equivalent specifications may be substituted. To ensure optimum results, the test must be performed at an ambient temperature of 22 to 24 degrees Celsius, with a relative humidity of less than 85%. Also, the instrument should be allowed to warmup for at least 30 minutes before starting the performance test.

4-42. If the instrument does not meet the performance test, troubleshooting, repair, and/or calibration adjustment is indicated. Procedures for calibration adjustment and troubleshooting are given later in this section of the manual.

4-43. Initial Conditions

4-44. Before starting the following procedures, condition the 5220A as follows:

1. Disconnect all input, output, and remote connections at the 5220A.

2. Install the top, bottom, and inner covers if they have been removed.

3. Connect the unit to line power through an autotransformer set for the proper line voltage, and set the POWER switch to ON. Only the STANDBY and FRONT LEDs should light.

4. Allow the 5220A to warmup for at least 30 minutes before proceeding.

4-45. Front Panel Tests

4-46. Use the following procedure to check the operation of the 5220A front-panel controls and LEDs:

1. With the unit in the standby mode, connect jumper wires between the enabled (front/rear) output terminals. Use a 4-inch length of 16-gauge insulated wire.

2. Press the OPR/STDBY pushbutton. The OPR LED should light and the STDBY LED should go out.

3. Press the INPUT pushbutton to select the rear input.

4. Return input control to the front panel by pressing the INPUT pushbutton. The FRONT LED should light and the REAR LED should go out.

5. Remove the jumper wire from the output terminals. The unit should switch to the standby mode and the OVERCOMPLIANCE LED should light.

6. Reinstall the jumper wire at the output terminals.

7. Clear the overcompliance condition by pressing the OPR/STDBY switch. Set the unit to the operate mode.

CAUTION

The THERMAL CUTOFF LED will light only when the output stage of the 5220A is overheated. This is a failure mode that should not be invoked for test purposes. The LOCAL pushbutton and the REMOTE, LOCAL LOCKOUT LEDs are remote control features that require remote commands for operation.

4-47. Zero Output

4-48. The following procedure checks the zero output of the 5220A in both the standby and operate modes:

1. Connect the load resistor (0.1 ohm) to the enabled (front/rear) output terminals.

2. Connect the DVM to the sense terminals on the load resistor and select the 100 mV dc range.

3. With the 5220A in the standby mode, read the voltage drop across the load resistor. The reading should be 0 ±5μV dc.

4. Connect a short jumper wire between the front VOLTAGE INPUT terminals.

5. Set the 5220A to the operate mode. The OPR LED should be on and the STDBY LED off.

6. Read the output voltage on the DVM. It should be 0 ±100μV dc.

7. Set the 5220A to standby and remove the jumper wire from the VOLTAGE INPUT terminals.

8. Disconnect the load resistor from the output terminals on the 5220A.

4-49. DC Accuracy and Line Regulation

4-50. The following procedure is used to check the dc accuracy of the 5220A output current:

1. Connect the precision shunt to the enabled output terminals on the 5220A.

2. Connect the DVM to the sense terminals on the precision shunt. Observe polarity.

3. Set the DVM to the 200 mV dc range.

4. Connect the output of the dc voltage calibrator to the VOLTAGE INPUT terminals on the 5220A; positive to red, negative to black.

5. Set the dc voltage calibrator to the output shown in step 1 of Table 4-2 (+10.0000V dc).

Table 4-2. DC Accuracy Test

STEP	DC CALIBRATOR OUTPUT (V dc)	CALCULATED OUTPUT CURRENT (AMPS)
1	+10.0000	+9.9965 to +10.0035
2	+20.0000	+19.9940 to +20.0060
3	−10.0000	−10.0035 to −9.9965

6. Set the 5220A to the operate mode.

7. Using the DVM reading and the calibrated shunt value, calculate the output current (I = E/R). The calculated value should be within the limits shown in the table.

8. Vary the line voltage ±10% from nominal and verify a less than 0.001% change in output current.

9. Sequentially set the calibrator output to the voltages shown in steps 2 and 3 of Table 4-2. At each voltage setting verify the 5220A output accuracy by repeating step 7 of this procedure.

10. Set the 5220A to the standby mode.

11. Set the dc voltage calibrator output to zero volts and disconnect it from the 5220A.

12. Disconnect the precision shunt from the 5220A output terminals.

4-51. Harmonic Distortion

4-52. This procedure is used to measure the harmonic distortion present at the output of the 5220A.

1. Set the output of the ac voltage calibrator to zero and connect it to the 5220A VOLTAGE INPUT terminals.

2. Connect the load resistor (0.1 ohms) to the enabled (front/rear) output terminals.

3. Connect the distortion analyzer to load resistor sense terminals.

4. Set the ac voltage calibrator output to 20V rms at 1 kHz.

5. Set the 5220A to the operate mode.

6. Measure the output distortion on the distortion analyzer. It should be less than or equal to 0.05%.

NOTE

Do not use input filters when making this measurement.

7. Set the 5220A to the standby mode.

8. Disconnect the load resistor and the distortion analyzer from the 5220A output terminals.

4-53. Frequency Response

TWISTED PAIR ON OUTPUT

4-54. The frequency response of the 5220A is checked using the following procedure:

1. Connect the precision shunt (.01 ohm) to the enabled (front/rear) output terminals.

2. Connect the true rms voltmeter to the sense terminals on the precision shunt. *

3. Set the ac voltage calibrator output to the voltage and frequency shown in step 1 of Table 4-3 (20.0000V @ 100 Hz).

Table 4-3. Frequency Response Test

STEP	AC VOLTAGE CALIBRATOR OUTPUT (V rms)	MEASURED OUTPUT CURRENT (AMPS)
1	20V @ 100 Hz	19.970-20.030*
2	20V @ 300 Hz	Reading 1 ±.05%
3	20V @ 1 kHz	Reading 1 ±.05%
4	20V @ 3 kHz	Reading 1 ±.15%
5	20V @ 5 kHz	Reading 1 ±.25%

*Includes limit of errors for:
1. 5220A
2. 5200A
3. Y5020
4. 931A

4. Set the 5220A to the operate mode.

5. Read the true rms voltmeter and calculate the current. It should indicate a current within the limits shown for step 1.

6. Sequentially set the calibrator output to each of the frequencies shown in steps 2 through 5 of Table 4-3. At each frequency verify that the measured current is within the limits given for that step.

7. Set the 5220A to the standby mode.

8. Disconnect the precision shunt from the 5220A output terminals.

4-55. Overcurrent Trip Test

4-56. The following procedure will verify the accuracy of the overcurrent trip setting on the 5220A:

1. Connect the load resistor (0.1 ohm) to the enabled (front/rear) output terminals.

2. Set the output of the ac voltage calibrator to 20.0000V rms.

3. Set the 5220A to the operate mode.

4. Increase the ac voltage calibrator output in 1.0V rms increments. The 5220A should switch to the standby mode at between 20.0 and 24.0V rms. The OVERCURRENT LED should also light.

5. Set the ac voltage calibrator output to zero volts.

6. Disconnect the load resistor from the 5220A output terminals.

* KEEP MONITOR MTR AWAY 5220A

4-57. Overvoltage Trip Test

4-58. The following procedure is used to check the overvoltage trip setting on the 5220A:

1. Connect a 1 ohm ±5%, 10 watt resistor to the enabled (front/rear) output terminals on the 5220A.

2. Set the output of the 5220A to 3.0000V rms.

3. Set the 5220A to the operate mode.

4. Increase the ac voltage calibrator output in 0.1V rms increments. The 5220A should switch to the standby mode with an input of 3.1 to 3.5V rms. The OVERVOLTAGE LED should also light.

COMPLIANCE

5. Set the ac voltage calibrator output to zero volts and disconnect the unit from the 5220A.

6. Remove the 1 ohm, 10 watt resistor from the 5220A output terminals.

7. Set the 5220A POWER switch to OFF.

4-59. CALIBRATION ADJUSTMENTS

4-60. The calibration adjustment procedures given in the following paragraphs should be performed after repair of the 5220A and/or when the unit fails the

performance-test requirements. If the unit will not respond to, or meet the limits of the adjustment procedures, troubleshooting and repair is indicated. Equipment required for the calibration adjustments is listed earlier in Table 4-1.

4-61. All calibration adjustments are accessible when the top and large inner covers are removed from the 5220A. Figure 4-1 identifies the location of the assemblies, test points, and adjustments that must be accessed to complete the calibration adjustment procedures.

4-62. To ensure optimum results, the caibration adjustments must be performed at an ambient temperature of 22 to 24 degrees Celsius, with a relative humidity of less than 85%. Also the unit should be allowed to warmup in the operate mode (with the top cover in place) for at least 30 minutes before starting the adjustment procedures.

4-63. Initial Conditions

4-64. Before starting the following procedures, condition the 5220A as follows:

1. Disconnect all input and remote connections to the 5220A, and connect a short jumper wire between the selected output terminals.

2. Connect the unit to line power and set the POWER switch to ON. Only the STDBY and FRONT LEDs should light.

3. Set the 5220A to the operate mode and allow it to warmup for at least 30 minutes.

4. Remove the top and large inner cover from the unit, and complete the following procedures.

4-65. Input Offset Adjustment

4-66. The following procedure is used to adjust input offset (R6) on the A5 Preamplifier PCB Assembly:

1. Connect the load resistor (0.1 ohm) to the enabled (front/rear) 5220A output terminals.

2. Connect the DVM to the sense terminals on the load resistor and select the 100 mV dc range.

3. Connect a short jumper wire between the front VOLTAGE INPUT terminals.

4. Set the 5220A to the operate mode.

5. Adjust R6 on the A5 Preamplifier PCB Assembly for a DVM reading of –.010 to –.010 mV dc (0 ±10 μV dc).

6. Set the 5220A to the standby mode.

4-67. Driver Offset Adjustment

4-68. The following procedure is used to adjust input offset (R6) on the A6 Driver PCB Assembly. The procedure is accomplished with the 5220A in the standby mode:

1. Jumper test lead between TP7 (–15V dc) on the A4 Regulator and TP4 (Turn on 1) on the A6 Driver. This enables the A6 Driver and A7 Output while the A5 Preamplifier is clamped to zero (standby).

2. Adjust R6 on the A6 Driver for a DVM reading of –1.000 to +1.000 mV dc.

3. Disconnect the test lead from TP4 and TP7.

4. Remove the load resistor from the 5220A output terminals.

5. Remove the jumper wire from the front-panel VOLTAGE INPUT terminals.

4-69 Output Bias Adjustment

4-70. This procedure is used to adjust the bias current for both the A6 Driver and the A7 Output. The bias adjustment (R13) is located on the A6 Driver PCB Assembly.

1. Connect the ac voltage calibrator to the front-panel VOLTAGE INPUT terminals on the 5220A.

2. Connect the load resistor (.1 ohm) to the enabled output terminals on the 5220A.

3. Connect the distortion analyzer input to the sense terminals on the load resistor.

4. Set the ac voltage calibrator for a 20V rms, 1 kHz output.

5. Set the 5220A to the operate mode.

6. Measure the distortion and adjust R13 for a minimum indication. At the final setting, distortion should measure less than 0.04%.

7. Set the 5220A to the standby mode.

8. Disconnect the distortion analyzer and the load resistor from the 5220A.

4-71. DC Accuracy Adjustment

4-72. This procedure is used to adjust R3 on the A5 Preamplifier PCB Assembly. This adjustment controls the accuracy of the dc output current.

1. Connect the precision shunt (.01 ohm) to the enabled output terminals on the 5220A.

2. Connect the DVM to the sense terminals on the precision shunt. Observe polarity.

3. Connect the output of the dc voltage calibrator to the VOLTAGE INPUT terminals on the 5220A; positive to red, negative to black.

4. Set the dc voltage calibrator for an output 4 of +10.0000V dc.

5. Set the 5220A to the operate mode.

6. Adjust R3 on the A5 Preamplifier for a voltage reading in millivolts that is 10 times the calibrated value of the precision shunt in milliohms. The adjustment should be within ±.002 mV dc of the calculated value. For example: if the calibrated value of the shunt is 0.0100253, adjust R3 for a DVM reading of .100253V dc or 100.253 ±.002 mV dc.

7. Set the 5220A to the standby mode.

8. Disconnect both the dc voltage calibrator and the precision shunt from the 5220A.

4-73. Frequency Response

4-74. The following procedure is used to adjust the frequency response of the 5220A. The adjustment is made at C4 on the A5 Preamplifier PCB Assembly.

1. Connect the precision shunt to the enabled output terminals on the 5220A.

2. Connect the true rms voltmeter to the sense terminals on the precision shunt.

3. Set the output of the ac voltage calibrator to 10V rms, 1 kHz.

4. Set the 5220A to the operate mode.

5. Note the reading on the rms voltmeter.

6. Change the frequency of the calibrator output to 5 kHz.

7. Adjust trimmer capacitor C4 on the A5 Preamplifier PCB to obtain the same reading on the rms voltmeter as that noted in step 5.

8. Set the 5220A to the standby mode.

9. Disconnect the shunt and voltmeter from the 5220A output terminals.

4-75. Overcurrent Adjustment

4-76. This procedure is used to adjust the overcurrent trip level of the 5220A. The overcurrent adjustment (R21) is located on the A8 Analog Control PCB Assembly.

1. Connect the load resistor (0.1 ohm) to the enabled output terminals on the 5220A.

2. Set the calibrator output to 23.5V rms, 50 Hz.

3. Set the 5220A to the operate mode. If the unit switches back to standby, turn R21 (on the A8 Analog Control PCB Assembly) counterclockwise until the operate mode can be enabled.

4. Adjust R21 clockwise until the 5220A switches to the standby mode. Both the STDBY and OVERCURRENT LEDs should light.

5. Disconnect the 0.1 ohm load resistor from the 5220A output terminals.

4-77. Overvoltage Adjustment

4-78. This procedure is used to adjust the overvoltage trip level for the 5220A. The overvoltage adjustment (R9) is located on the A8 Analog Control PCB Assembly.

1. Connect the 1 ohm load resistor to the enabled output terminals on the 5220A.

2. Set the ac voltage calibrator output for 3.3V rms, 50 Hz.

3. Set the 5220A to the operate mode. If the unit switches back to standby, turn R9 (on the A8 Analog Control PCB Assembly) counterclockwise until the operate mode can be enabled.

4. Adjust R9 clockwise until the 5220A switches to the standby mode. Both the STDBY and OVERCOMPLIANCE LEDs should light.

5. Disconnect the load resistor and the ac voltage calibrator from the 5220A.

6. Set the 5220A POWER switch to OFF.

7. Disconnect the unit from line power.

8. Install the inner cover and top cover on the 5220A.

4-79. REPLACEMENT OF SELECTED COMPONENTS

4-80. The A5 Preamplifier PCB Assembly contains a series of three selected parts that may have to be changed after repairs have been made on the pcb. All three selected parts are resistors. Two (R11, R12) are associated with the Input Offset Adjustment (R6); the third (R13) affects the DC Accuracy Adjustment (R3). Resistors R11 and R12 are selected to place R6 at approximately midrange when it is properly adjusted. Resistor R13 is selected to accomplish the same thing for R3. When the travel of either R3 or R6 limits proper adjustment, the associated selected resistor(s) should be replaced. Follow the appropriate procedure for parts selection.

4-81. Resistors R11 and R12

4-82. Resistors R11 and R12 are associated with the Input Offset Adjustment procedure and the setting of the ZERO ADJ potentiometer R6. Use the following procedure to select the proper replacements for R11 and R12:

1. Disconnect the 5220A from line power.

2. Remove the top and large inner covers from the unit.

3. Remove the two fuses (F1 and F2) from the A3 Cap Bus PCB Assembly.

4. Mount the A5 Preamplifier PCB Assembly on the extender board and install jumper wires on the pcb at the following points.

   a. TP1 to TP5

   b. TP3 to TP4

   c. Short across R11

   d. Short across R12

5. Disconnect the red and black Current Shunt sense lead from the motherboard (connections are located near the A5 Preamplifier connector).

6. Set the digital voltmeter to the 100 mV dc range and connect its input to TP4 (+) and TP5 (–) on the A5 Preamplifier PCB Assembly.

7. Adjust R6 on the A5 Preamplifier to the full ccw (counterclockwise) position.

8. Connect the 5220A to line power and set the POWER switch to ON.

9. Select the operate mode using the STDBY/OPR switch.

10. Note the DVM reading. It should read within the range of ±1.300 mV dc.

11. Adjust R6 on the A5 Preamplifier PCB to the full cw (clockwise) position and note the reading. The DVM reading should increase in a positive direction.

12. Calculate the difference between the DVM readings taken in steps 10 and 11. The difference should be 0.700 ±0.140 mV dc.

13. Determine the average reading of steps 10 and 11 and adjust R6 for that reading on the DVM. Then perform step a, b, or c as required.

   a. If the DVM reading is within the range of ±0.087 mV dc, replace both R11 and R12 with shorting wires (0Ω).

   b. If the DVM reading is negative, refer to Table 4-4, and replace R12 with the appropriate resistor. Replace R11 with a shorting wire.

   c. If the DVM reading is positive, refer to Table 4-4 and replace R11 with the appropriate resistor. Replace R12 with a shorting wire.

14. Set the POWER switch to OFF and disconnect the 5220A from line power.

15. Install the two fuses (F1 and F2) on the A3 Cap Bus PCB Assembly.

16. Remove the jumpers from TP1-TP5 and TP3-TP4.

17. Disconnect the DVM from TP4 and TP5.

18. Remove the A5 Preamplifier PCB from the extender board.

19. Reconnect the red and black current shunt sense leads to the motherboard.

20. Install the A5 Preamplifier PCB Assembly in its slot.

21. Perform the Calibration Adjustment procedures.

Table 4-4. Replacement Resistors for R11 and R12

DVM READING (± mV dc)	SELECTED VALUE FOR R11/R12	FLUKE PART NUMBER
.088 to .261	1.00 kΩ	168229
.262 to .437	2.00 kΩ	235226
.438 to .611	3.01 kΩ	312645
.612 to .787	4.02 kΩ	235325
.788 to .961	4.99 kΩ	~~186252~~ 168252
.962 to 1.137	6.04 kΩ	285189
1.13 to 1.312	6.98 kΩ	~~161685~~ 261685

4-83. Resistor R13

4-84. Resistor R13 is associated with the DC Accuracy Adjustment procedure and the setting of the GAIN ADJ potentiometer R3. Use the following procedure to select the proper replacement for R13:

1. Disconnect the 5220A from line power.

2. Remove the top and large inner covers from the unit.

3. Connect the precision shunt (.01 ohm) to the enabled output terminals of the 5220A.

4. Connect the DVM to the sense terminals on the precision shunt; observe polarity. Set the DVM to the 100 mV range and zero the display ±.001 mV.

5. Connect the output of the dc voltage calibrator to the VOLTAGE INPUT terminals on the 5220A; positive to red, negative to black.

6. Adjust R3 on the A5 Preamplifier to its full cw limit.

7. Install a shorting wire across R13 on the A5 Preamplifier PCB Assembly.

8. Connect the 5220A to line power and set the POWER switch to ON.

9. Set the calibrator for an output of +10.0000V dc.

10. Set the 5220A to the operate mode.

11. Determine the actual value of the precision shunt (calibrated value) and subtract it from .01 ohms. Multiply this difference by 10,000 and record the result.

12. Record the displayed DVM reading in mV and subtract the result of step 11 ~~from~~ the reading. Use this corrected DVM reading in conjunction with Table 4-5, to select the value of R13.

For example:

Given: Shunt Value = .0100123Ω

DVM Reading = 101.041 mV dc

Corrected DVM Reading = 101.041 + (10000 × .01 −.010012)

Corrected DVM Reading = 100.918 mV dc

R13 = 698 ohms (see Table 4-5.)

13. Set the POWER switch on the 5220A to OFF and replace R13 on the A5 Preamplifier PCB with the selected value.

14. Perform the Calibration Adjustment procedures.

Table 4-5. Replacement Resistors for R13

CORRECTED DVM INDICATION (mV dc)	SELECTED VALUE FOR R13 (ohms)	FLUKE PART NUMBER
102.000 to 101.800	1740 Ω	357756
101.800 to 101.600	1500 Ω	376947
101.600 to 101.400	1282 Ω	330472
101.400 to 101.200	1100 Ω	347161
101.200 to 101.000	900 Ω	460519
101.000 to 100.800	698 Ω	289330
100.800 to 100.600	499 Ω	289256
100.600 to 100.400	301 Ω	~~789173~~ 289173
100.400 to 100.200	100 Ω	357400
100.200 to 100.000	0 Ω	-----

4-85. TROUBLESHOOTING

CAUTION

Static discharge can damage MOS components contained in the 5220A. To prevent this possibility use the following precautions when troubleshooting and/or repairing the unit.

1. Never remove, install, or otherwise connect, or disconnect pcbs and/or components without disconnecting the unit from line power.

2. Perform all repairs at a static-free work station.

3. Do not handle ICs or pcbs by their connectors.

4. Use static ground straps to discharge repair personnel.

5. Use conductive foam to store replacement or removed ICs.

6. Remove all plastic, vinyl, and Styrofoam products from the work area.

7. Use a grounded soldering iron.

4-86. The following troubleshooting information is designed for use in isolating a mainframe malfunction to the pcb (board) level. Details necessary to troubleshoot faulty pcbs to the component level can be derived from the the schematic diagrams given in Section 8, and the Theory of Operation in Section 3.

4-87. Troubleshooting information is presented in a series of interrelated figures and tables. Figure 4-3, identifies the available pcb test points and their location. Figures 4-4 and 4-5, give a flowchart summary of the actual procedures contained in Tables 4-6 and 4-7.

4-88. When using the troubleshooting guides, the following notes apply:

1. Do not start in the middle of the procedure. Any given step assumes that the previous steps have been completed. Complete Table 4-6 before going on to Table 4-7.

2. All measurements using externnal test equipment are made at test points on the various pcb assemblies. See Figure 4-3 for test point location/identification.

TP SIGNAL

1 +5V ISO (COM TP2)
2 COM 4 (ISO)
3 +15V dc (COM TP5)
4 COM 3
5 COM 1
6 +5V dc (COM TP4)
7 −15V dc (COM TP5)
8 LINE MON(ITOR)

1 PREAMP INPUT 1
2 PREAMP INPUT 2
3 SHUNT SENSE 2
4 DRIVE IN
5 COM 1
6 FET DRIVE 1
7 COM 3

1 SHUNT SENSE 1
2 BIAS VOLTAGE
3 SHUNT SENSE 2
4 DRIVE IN

1 + DRIVE
2 − DRIVE
3 Q103 SHUNT
4 Q104 SHUNT
5 Q105 SHUNT
6 Q106 SHUNT
7 OUT +

1 OVERCOMPLIANCE
2 OVERCURRENT
3 COM 3
4 TURN ON 1
5 FET DRIVE 1
7 I TRIP LEVEL
8 I DETECTOR OUTPUT
9 COM 1
10 V TRIP LEVEL
11 V DETECTOR OUTPUT
12 OUT +
13 COM 2

1 COM 3
2 +5V dc

1 COM 3
2 +5V dc

1 COM 4
2 +5V dc ISO

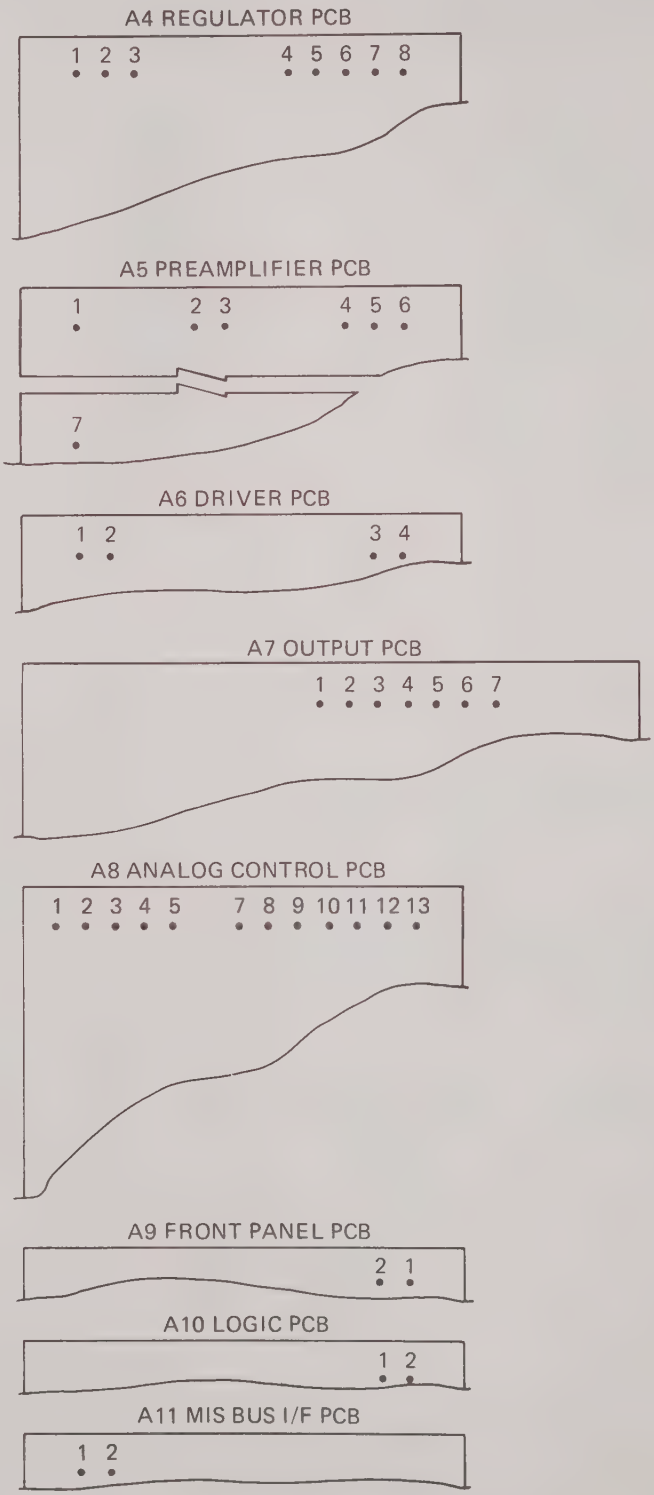

A4 REGULATOR PCB
1 2 3 4 5 6 7 8
A5 PREAMPLIFIER PCB
1 2 3 4 5 6
7
A6 DRIVER PCB
1 2 3 4
A7 OUTPUT PCB
1 2 3 4 5 6 7
A8 ANALOG CONTROL PCB
1 2 3 4 5 7 8 9 10 11 12 13
A9 FRONT PANEL PCB
2 1
A10 LOGIC PCB
1 2
A11 MIS BUS I/F PCB
1 2

Figure 4-3. Test Point Location/Identification

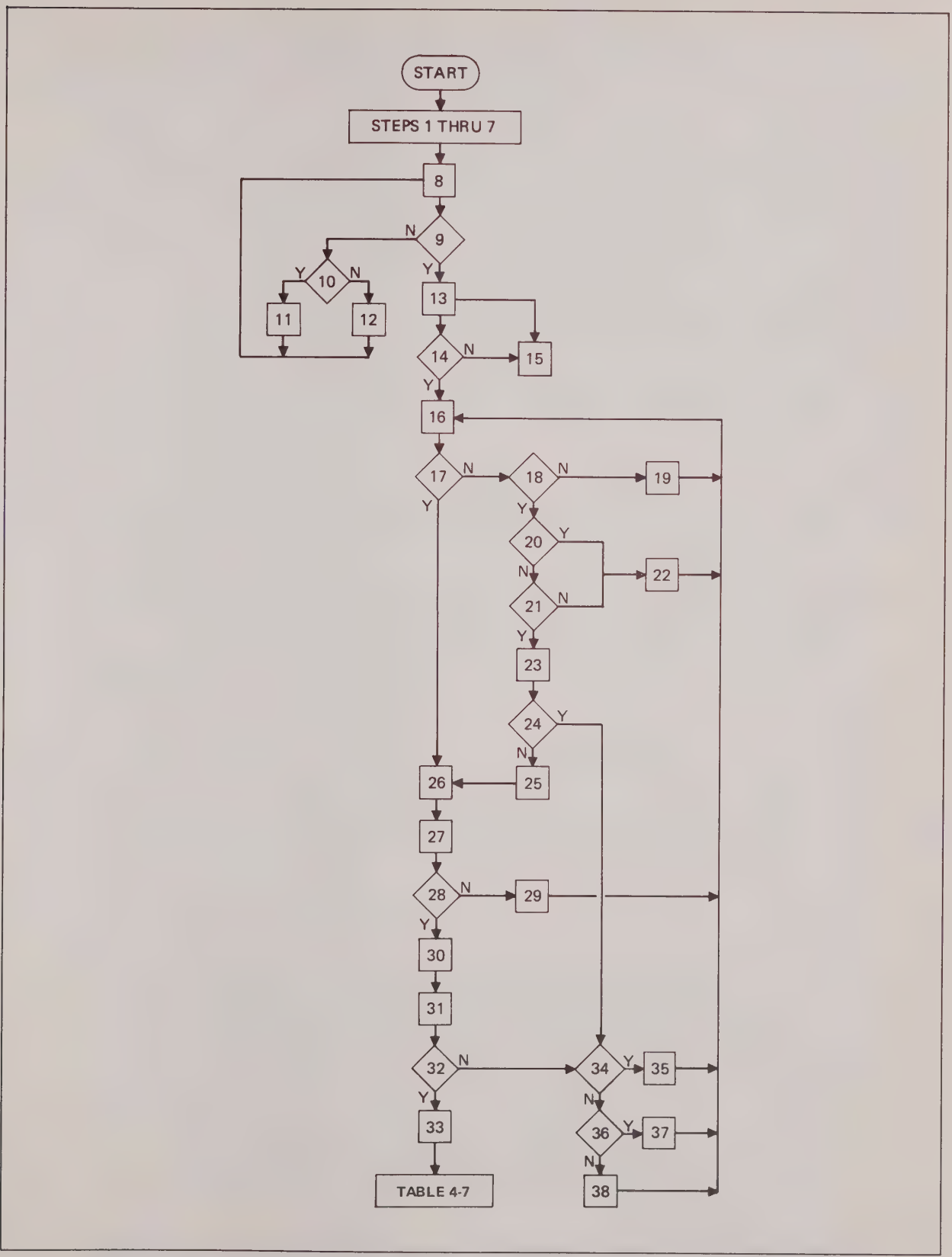


Figure4-4. Flowchart Summary of Mainframe and Digital Section Troubleshooting Guide (Table 4-6)

Table 4-6. Mainframe and Digital Section Troubleshooting Guide

STEP NO.	INSTRUCTION	YES	NO	GO TO
1	Set the 5220A POWER switch to OFF and disconnect the unit from line power.			2
2	Remove the top cover and the large inner cover from the 5220A.			3
3	Visually inspect the internal fuses (F2 through F7) and replace as required.			4
4	Connect a shorting jumper between the front panel VOLTAGE INPUT terminals.			5
5	Check to ensure that all pcb assemblies are securely installed in the correct locations. See Figure 4-1.			6
6	Determine the enabled output terminals by visually identifying the position of the front/rear output jumper screws. Tighten these screws if they are loose.			7
7	Connect a shorting jumper between the enabled output terminals.			8
8	Connect the 5220A to line power and set the POWER switch to ON.			9
9	Is the fan running?	13	10	
10	Are any of the front panel LEDs lit?	11	12	
11	Loose fan connections or defective fan. Repair as required.			8
12	Check the line power fuse and replace if necessary. If fuse continues to blow, locate short in input power circuit/transformer assembly. Check the position of the line voltage switches on the transformer assembly.			
13	Using a dc voltmeter, verify the presence of all power supply voltages at the A4 Regulator PCB and the A3 Cap Bus. Test points are provided on the A4 Regulator PCB. Measure the A3 Cap Bus outputs (±12V dc) at the bus bar terminals on that assembly with respect to COM 2 (the ground plane on top of the A3 Cap Bus PCB).			
	VOLTAGE / TEST POINTS HI / TEST POINTS LO / LIMITS			
	A4 REGULATOR			
	+15V / 3 / 5 / +14.4 to +15.6V dc			
	−15V / 7 / 5 / −15.6 to −14.4V dc			
	+5V ISO / 1 / 2 / +4.8 to +5.2V dc			
	+5V / 6 / 4 / +4.8 to +5.2V dc			
	A3 CAP BUS			
	+12V / — / — / +10.5 to +13.5V dc			
	−12V / — / — / −12.5 to −10.5V dc			
14	Are all voltages within limits?	16	15	
15	Check the line voltage switch settings on A2 Transformer Assembly. They should be set to comply with the local line voltage. If some voltages are in limits and some are out, the problem is on the A4 Regulator or the A3 Cap Bus. If a voltage is low, check for power supply loading. If a voltage is high, the regulator IC is likely cause.			
	FRONT PANEL TESTS			
16	Complete the Front Panel Tests described earlier under Performance Test.			17
17	Does the 5220A respond as described in the Front Panel Tests?			
18	Do one or more LEDs light?	20	19	

Table 4-6. Mainframe and Digital Section Troubleshooting Guide (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
19	Operating voltage (+5V dc) is not present at either th A9 Front Panel PCB or the A10 Logic PCB. Repair as required.			
20	Can the standby/operate modes be selected? *NOTE* *The jumper wire must be installed between the enabled output terminals.*			
21	Is OVERCURRENT or OVERCOMPLIANCE LED lit?	23	22	
22	Defective switch, LED, or standby/operate circuit (on the A10 Logic PCB).			16
23	Set the POWER switch to OFF, then ON.			
24	Is the OVERCOMPLIANCE or OVERVOLTAGE LED lit?	34	25	
25	Connect a 0.1 ohm resistor between the selected output terminals, then connect a DVM across the 0.1 ohm resistors.			26
26	Connect a jumper wire between TP4 (Turn on 1) on the A8 Analog Control PCB and TP7 (−15V) on the A4 Regulator PCB).			27
27	With the 5220A in standby, adjust R6 on the A6 Driver for a DVM reading of zero volts ±1.0 mV.			28
28	Can a zero volt DVM reading be obtained?	30	29	
29	The A6 Driver and/or A7 Output Assemblies are defective. Repair as required.			16
30	The A6 Driver and A7 Output Assemblies are functional. Remove the jumper from between TP4 and the A8 Analog Control PCB and TP17 on the A4 Regulator.			31
31	Press the STDBY/OPR switch.			32
32	Can the operate mode be selected?	33	34	
33	The mainframe and digital section are operational; the transconductance amplifier (A5, A6, A7) is defective. Check out and repair the transconductance amplifier using Table 4-7, Analog Section Troubleshooting Guide.			16
34	Is OVERCURRENT LED lit?	35	36	
35	Check the following and repair as required: 1. Open feedback loop, current shunt to A5 Preamplifier. 2. Overcurrent detector on A8 PCB. 3. Failure status logic on A10 PCB. 4. Defective A5 Preamplifier PCB.			

Table 4-6. Mainframe and Digital Section Troubleshooting Guide (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
36	Is OVERCOMPLIANCE LED lit?	37	38	
37	Check the following and repair as required: 1. Overvoltage detector on A8 PCB. 2. Open loop on transconductance amplifier (A5, A6, A7 PCBs). 3. Failure status circuit on the A10 PCB. 4. Open load or open circuit between output amplifier and output terminals.			16
38	Check timing logic on the A10 Logic PCB, and the level shifters on the A8 Analog Control PCB. Repair as required.			16

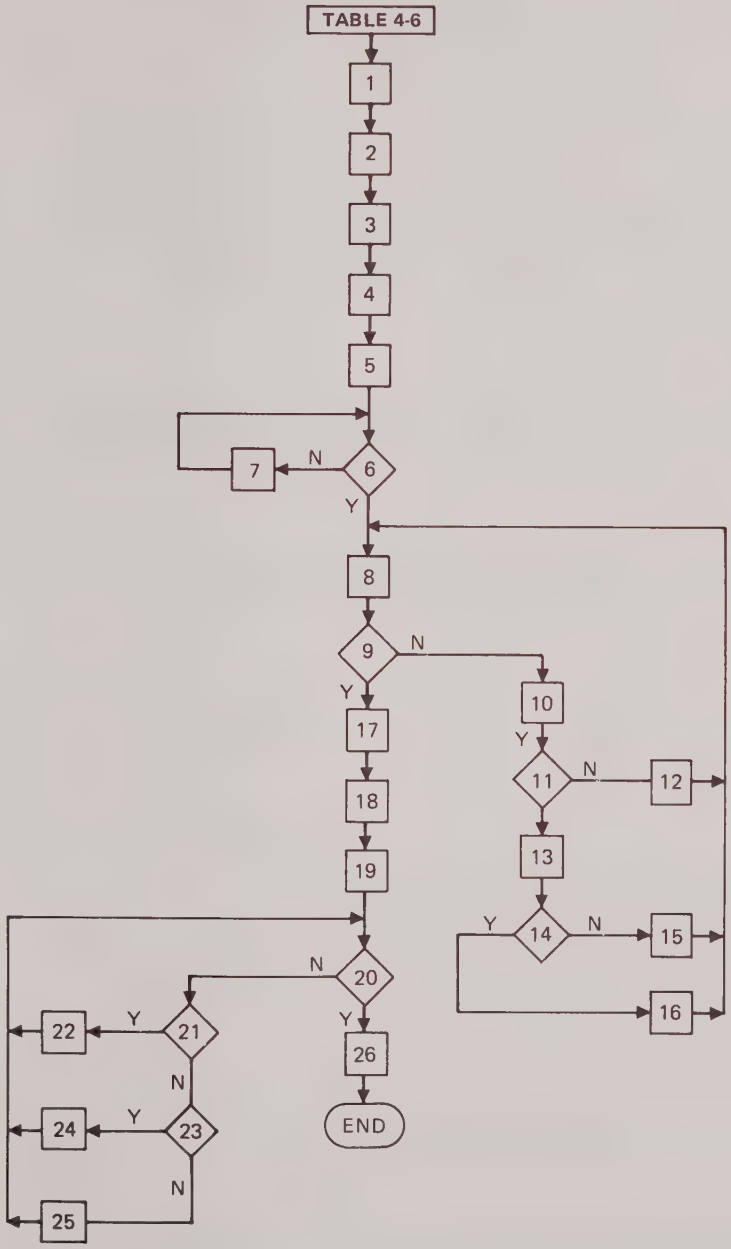


Figure 4-5. Flowchart Summary of Analog Section Troubleshooting Guide (Table 4-7)

Table 4-7. Analog Section Troubleshooting Guide

STEP NO.	INSTRUCTION	YES	NO	GO TO
1	Complete the troubleshooting procedure given in Table 4-6.			2
2	Set the 5220A POWER switch to OFF.			3
3	Connect a jumper wire between the front panel VOLTAGE INPUT terminals.			4
4	Connect a 0.1 ohm resistor between the selected output terminals, then connect a DVM across the 0.1 ohm resistor.			5
5	Set the POWER switch to ON and select the operate mode.			6
6	Does the 5220A remain in the operate mode?	8	9	
7	If the 5220A trips to standby and indicates an overcompliance or overcurrent condition, the A5 Preamplifier PCB is at fault. Check voltage levels on the active components on the A5 Preamplifier PCB while the unit is in standby. Repair as required.			8
8	Using a tuning tool, adjust R1, Zero Adjust, on the A5 Preamplifier PCB for a DVM reading of 0 ±3 μV dc. The adjustment should cover a range of 0 ±5 μV.			9
9	Can R6 be adjusted for a DVM reading of 0 ±3 μV?	17	10	
10	Connect the DVM from TP4 (high) to TP3 (low) on the A8 Analog Control PCB. With the 5220A in the operate mode the DVM should read −15V dc.			11
11	Does the DVM read −15V dc?	13	14	
12	Troubleshoot the Turn on 1 circuit starting with the level shifting transistors Q3 and Q4 on the A8 Analog Control PCB Assembly. Then check for a T1 output from U22 on the A10 Logic PCB Assembly. Repair as required.			
13	Connect the DVM from TP6 (high) to TP5 (low) on the A5 Preamplifier PCB Assembly. With the 5220A in the operate mode the DVM should read −15V dc.			14
14	Does the DVM read −15V dc?	16	15	
15	Troubleshoot the FET Drive 1 circuit starting with the level shifting transistors Q1 and Q2 on the A8 Analog Control PCB Assembly. Then check for a T2 output from U22 on the A10 Logic PCB Assembly. Repair as required.			8
16	The A5 Preamplifier PCB Assembly is defective. Check voltage levels on the active components on the A5 Preamplifier PCB while the unit is in standby. Repair as required.			8
17	The A5 Preamplifier, A6 Driver, and A7 Output stages are operating properly. Set the 5220A to standby, remove and replace the front panel short at the VOLTAGE INPUT terminals with a 1.0V dc voltage source; positive to red, negative to black.			18
18	Reconnect the DVM across the 0.1 ohm resistor to the output terminals.			19

Table 4-7. Analog Section Troubleshooting Guide (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
19	Set the 5220A to the operate mode and read the DVM.			20
20	Does the DVM read approximately +0.1V dc?	27	22	
21	Does the DVM read approximately zero volts?	22	23	
22	Check relay K1 and associated drive circuits on the A5 Preamplifier PCB Assembly. Also check resistors R1, R3, R13 for open circuits. If these are OK, check the Relay 1 drive signal from the A10 Logic PCB Assembly.			
23	Is the DVM reading greater than 0.010V dc?	24	25	
24	The A6 Driver or A7 Output stage is defective. Check voltage levels on active components to isolate the fault. Repair as required.			20
25	The A5 Preamplifier is defective. Check voltage levels on active components to isolate the fault. Repair as required.			20
26	The 5220A is operational. Verify instrument compliance with published specifications by completing the Performance Test given earlier in this section of the manual.			—

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE NO.	TABLE PAGE	FIGURE NO.	FIGURE PAGE
Final Assembly	5220A T&B-5001	5-1	5-3	5-1	5-5
A1 Mother PCB Assembly	5220A-4001T	5-2	5-14	5-2	5-15
A2 Power Transformer Assembly	5220A-4201	5-3	5-16	5-3	5-17
A3 Capacitor Bus PCB Assembly	5220A-5001 Group 05	5-4	5-18	5-4	5-19
A4 Regulator PCB Assembly	5220A-4090T	5-5	5-20	5-5	5-21
A5 Preamplifier PCB Assembly	5220A-4050T	5-6	5-22	5-6	5-23
A6 Driver PCB Assembly	5220A-4030T	5-7	5-24	5-7	5-25
A7 Output PCB Assembly	5220A-4020T	5-8	5-26	5-8	5-27
A8 Analog Control PCB Assembly	5220A-4040T	5-9	5-29	5-9	5-31
A9 Front Panel PCB Assembly	5220A-4010T	5-10	5-32	5-10	5-33
A10 Logic PCB Assembly	5220A-4060T	5-11	5-34	5-11	5-36
A11 MIS Bus Interface PCB Assembly	5220A-4070T	5-12	5-37	5-12	5-38
A12 Shunt Assembly	5220A-4202	5-13	5-39	5-13	5-39
A13 Output Terminal PCB Assembly	5220A-4004	5-14	5-40	5-14	5-40
A14 Extender PCB Assembly	5220A-4003	5-15	5-41	5-15	5-41

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the Options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)
5. Manufacturer's Part Number.
6. Total Quantity of components per assembly.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked (see paragraph 5-7). In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended spares quantity for the items in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or its authorized representatives by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number and Revision Letter.
6. Instrument Model and Serial Number.

5-7. A Recommended Spare Parts Kit for your basic instrument is available from the factory. This kit contains those items listed in the REC QTY column of the parts list in the quantities recommended.

5-8. Parts price information is available from the John Fluke Mfg. Co., Inc. or its representatives. Prices are also available in a Fluke Replacement Parts Catalog, which is available on request.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. 5220A Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	FINAL ASSEMBLY, MODEL 5220A FIGURE 5-1						
A1	MOTHER PCB ASSEMBLY	491209	89536	491209	1		
A2	POWER TRANSFORMER ASSEMBLY	491282	89536	491282	1		
A3	CAPACITOR BUS PCB ASSEMBLY	ORDER	ONLY	REPLACEABLE PARTS	1		
A4	REGULATOR PCB ASSEMBLY	489690	89536	489690	1		
A5	PRE-AMPLIFIER PCB ASSEMBLY	487702	89536	487702	1		
A6	DRIVER PCB ASSEBMLY	491233	89536	491233	1		
A7	OUTPUT PCB ASSEMBLY	491225	89536	491225	1		
A8	ANALOG CONTROL PCB ASSEMBLY	491241	89536	491241	1		
A9	FRONT PANEL PCB ASSEMBLY	491217	89536	491217	1		
A10	LOGIC PCB ASSEMBLY	491258	89536	491258	1		
A11	MIS BUS INTERFACE PCB ASSEMBLY	491266	89536	491266	1		
A12	SHUNT ASSEMBLY	491290	89536	491290	1		
A13	OUTPUT TERMINAL PCB ASSEMBLY	491274	89536	491274	2		
A14	EXTENDER PCB ASSEMBLY	486217	89536	486217	1		
B1	FAN	103374	89536	103374	1		
C1	CAP, CER, 5000 PF, -0+100%, 1KV	355420	56289	41C169A3	1		
F1	FUSE, SLO-BLO, 3 AMP	109280	71400	MDA3	1		5
H1	NUT, HEX, 8-32	110544	89536	110544	10		
H2	NUT, HEX, 10-32	110536	89536	110536	2		
H3	NUT, HEX, NYLON, 8-32	110593	89536	110593	8		
H4	NUT, HEX, STEEL 1/4-28	110619	89536	110619	1		
H5	NUT, HEX, STEEL, 4-40	110635	89536	110635	2		
H6	SCREW, FHP, 6-32 X 1/4	320093	89536	320093	10		
H7	SCREW, FHP, 6-32 X 1/4	114470	89536	114470	14		
H8	SCREW, PHP, 6-32 X 1/4	152140	73734	19042	80		
H9	SCREW, PHP, 6-32 X 3/8	152165	73734	19044	6		
H10	SCREW, PHP, 6-32 X 1/2	152173	73734	19096	21		
H11	SCREW, FHP, 8-32 X 5/16	281725	89536	281725	14		
H12	SCREW, FHP, 8-32 X 3/8	114116	89536	114116	8		
H13	SCREW, NYLON, 8-32 X 1/2	501569	89536	501569	4		
H14	SCREW, SOCKET, 8-32	295105	89536	295105	8		
H16	SCREW, TRUSS HD, 10-32	352872	70290	AN526C-R	4		
H17	SCREW, PHP, 10-32 X 3/8	114314	89536	114314	16		
H18	SCREW, PHP, 6-32 X 1-1/2	114181	89536	114181	6		
H19	SCREW, PHP, 8-32 X 3/8	114124	89536	114124	14		
H20	SCREW, PHP, 8-32 X 1/2	159749	89536	159749	5		
H21	SCREW, FHP, 8-32 X 5/16	281725	89536	281725	10		
H22	WASHER, FLAT	110718	73734	AN960-416L	4		
H23	WASHER, SHOULDER	110833	86928	5604-64	4		
H24	SOCKET SCREW, 8-32	295105	89536	295105	4		
H25	CAP, KNURLED (TO MP2)	102889	20584	1445	1		
MP1	FOOT, BAIL STAND	292870	89536	282870	4		
MP2	BINDING POST	102707	20584	1444	1		
MP3	BINDING POST, BLACK	142984	58474	DF31BC	2		
MP4	BINDING POST, BLACK	275560	32767	820-45	1		
MP5	BINDING POST, RED	142976	58474	DF31RC	4		
MP6	BINDING POST, RED	275552	32767	820-65	1		
MP7	BRACKET, FAN	485953	89536	485953	1		

Table 5-1. 5220A Final Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP8	BRACKET, FRONT PANEL	486068	89536	486068	2		
MP9	BULKHEAD, FRONT	485920	89536	485920	1		
MP10	BULKHEAD, REAR	485938	89536	485938	1		
MP11	BUSHING, BLACK SNAP	102990	89536	102990	1		
MP12	CARD GUIDE	256461	23880	1450F	12		
MP13	CHASSIS, BOTTOM	485912	89536	485912	1		
MP14	CHASSIS, LEFT SIDE	485896	89536	485896	1		
MP15	CHASSIS, RIGHT SIDE	485904	89536	485904	1		
MP16	CLAMP, CABLE (W/ 4-IN TIE)	172080	06383	SST-1M	2		
MP18	CONNECTOR COVER PLATE	502781	89536	502781	1		
MP19	CORD SET (TO B1 FAN)	438424	89536	438424	1		
MP20	CORNER, REAR	486076	89536	486076	2		
MP21	COVER, BOTTOM	522532	89536	522532	1		
MP22	COVER, POWER SUPPLY	489500	89536	489500	1		
MP23	COVER, SHUNT	489948	89536	489948	1		
MP25	COVER, TOP	522524	89536	522524	1		
MP26	DECAL, PLASTIC COVER	394403	89536	394403	4		
MP27	DECAL REAR	502799	89536	502799	1		
MP28	DECAL, SIDE TRIM	295402	89536	295402	2		
MP29	FILTER ELEMENT	422543	82877	271018	1		
MP30	HANDLE, 7-INCH FRONT	394320	89536	394320	2		
MP32	SOLDER LUG	101048	79963	#46	2		
MP33	NAMEPLATE, SERIAL NUMBER	393975	89536	393975	1		
MP34	PANEL, FRONT	479618	89536	479618	1		
MP35	PANEL, REAR	485888	89536	485888	1		
MP36	PARTITION, REAR	485946	89536	485946	1		
MP37	PLATE, FRONT INPUT	485979	89536	485979	1		
MP38	PLATE, FRONT	485987	89536	485987	1		
MP39	PLATE, REAR	485995	89536	485995	1		
MP40	JACK, PLUG	101550	71002	403	4		
MP41	HOLE PLUG	187799	82240	B2328	7		
MP43	OUTPUT BUS, MINUS	489526	89536	489526	1		
MP44	OUTPUT BUS, PLUS AFT	489542	89536	489542	1		
MP45	OUTPUT BUS, PLUS FORWARD	489534	89536	489534	1		
MP46	OUTPUT BUS SPACER	489559	89536	489559	1		
MP47	RECEPTACLE, AC POWER	284166	82389	EAC 301	1		
MP48	FILTER RETAINER	489450	89536	489450	1		
MP49	SHIM, REAR CORNER	486050	89536	486050	2		
MP51	SHUNT BUS, PLUS	497974	89536	497974	1		
MP52	SHUNT BUS, MINUS	490524	89536	490524	1		
MP53	SPACER, CAPACITOR	489484	89536	489484	2		
MP54	SPACER, NYLON, 5-16 X 1/1-16	104174	89536	104174	4		
MP55	STAND-OFF, NYLON SLOTTED TERMINAL	271650	12615	SL-890-823	2		
MP56	CAPACITOR TRAY	486035	89536	486035	1		
W1	CORDSET (NOT SHOWN)	363481	89536	363481	1		
W2	CABLE, POWER (TO B1 FAN)	491308	89536	491308	1		
XF1	CAP, FUSEHOLDER	460238	*	FEU031.1666	1		
XF1	FUSEHOLDER, W/NUT *(MFR: SCHURTER CO.)	460329	*	FEU031.1673	1		
	5220A INSTRUCTION MANUAL	491936	89536	491936	1		
	RECOMMENDED SPARE PARTS KIT	527648	89536	527648	AR		

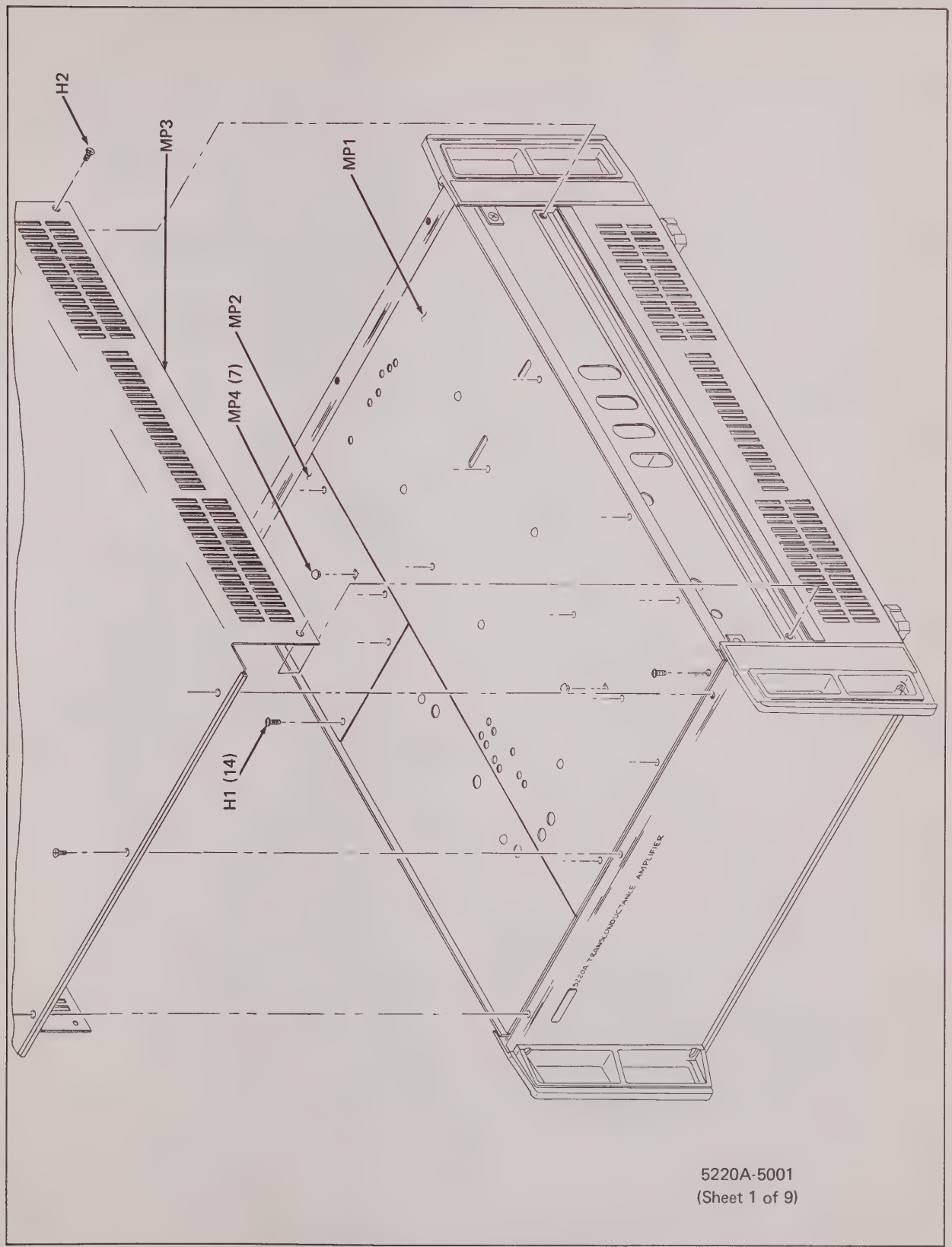


Figure 5-1. 5220A Final Assembly

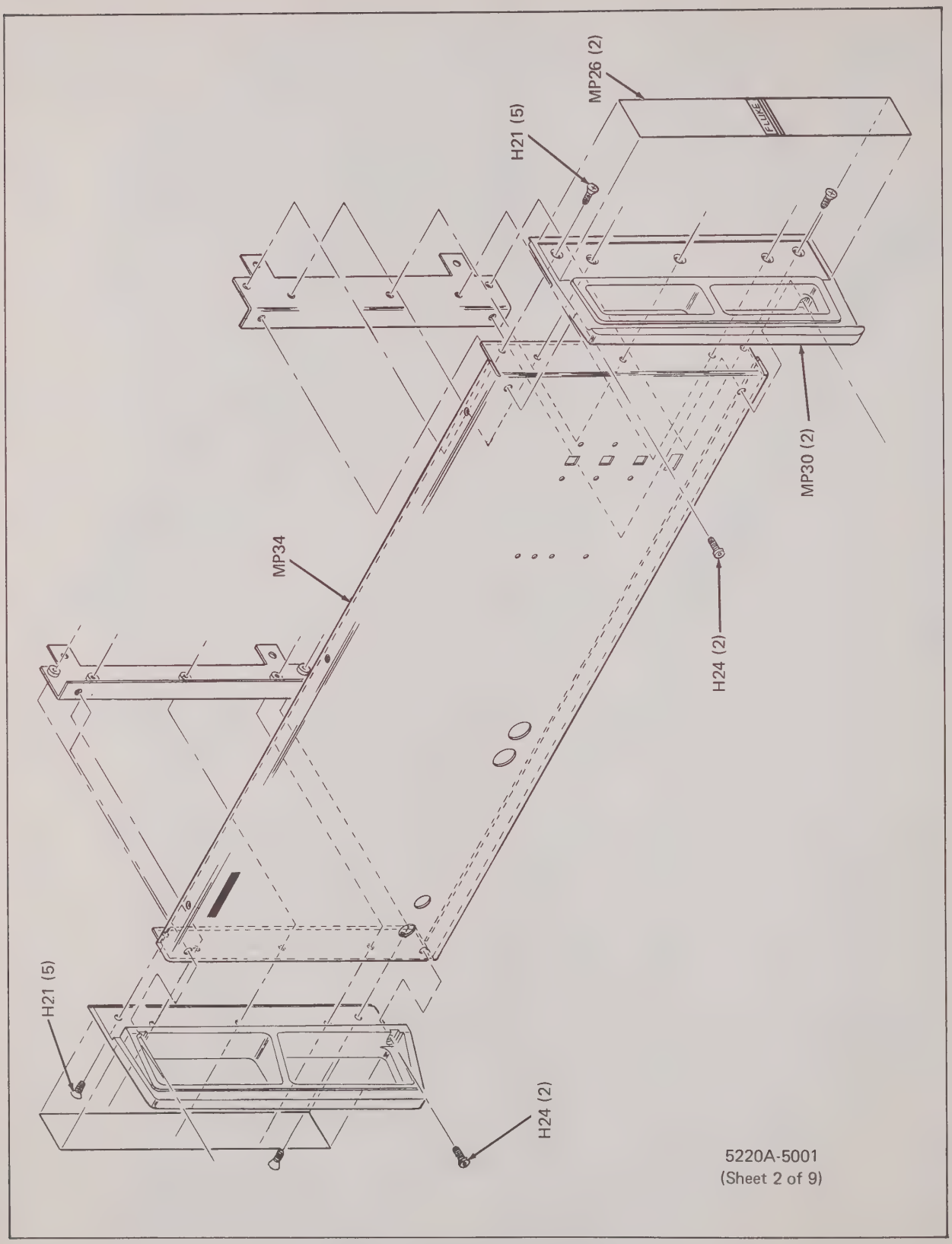


Figure 5-1. 5220A Final Assembly (cont)

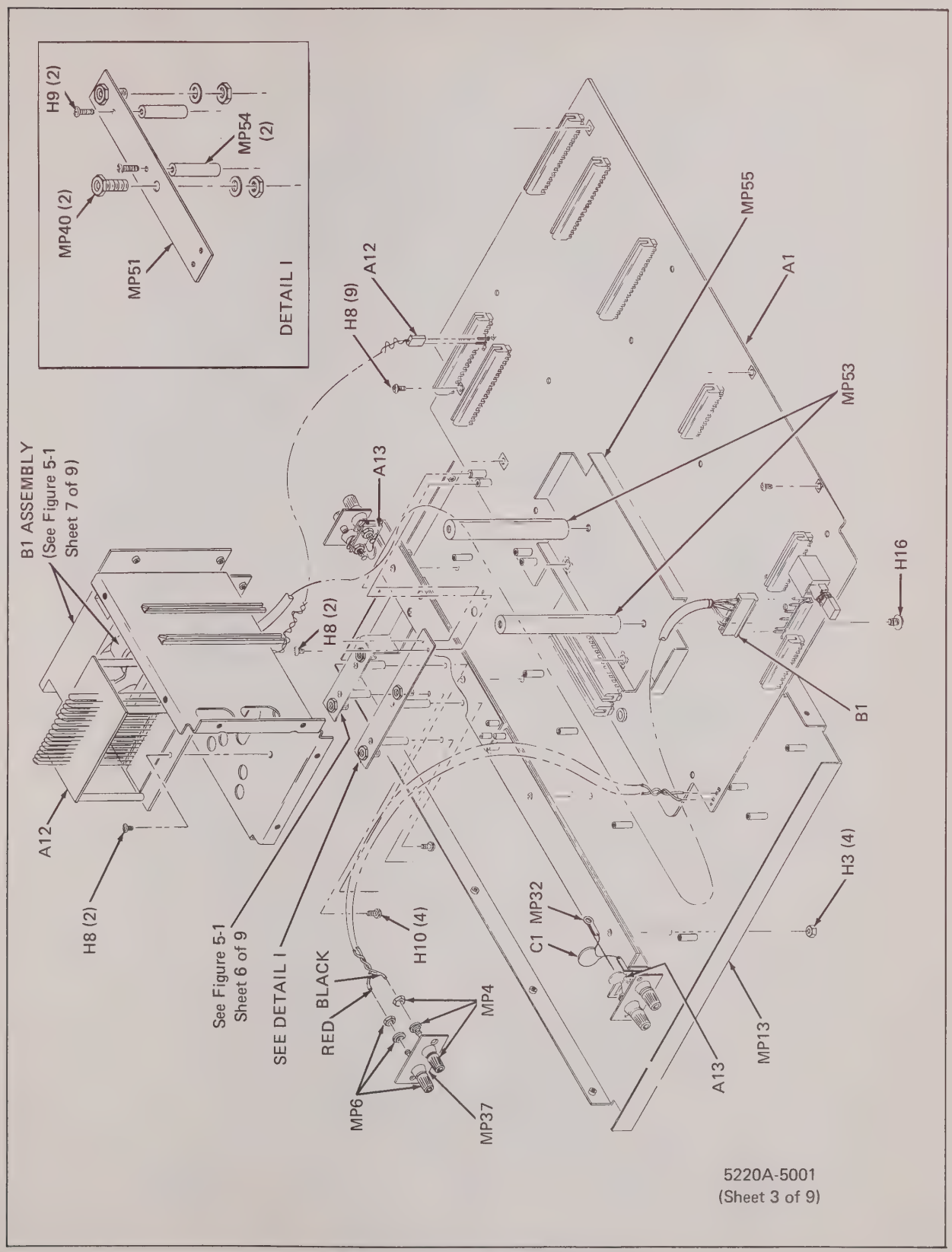


Figure 5-1. 5220A Final Assembly (cont)

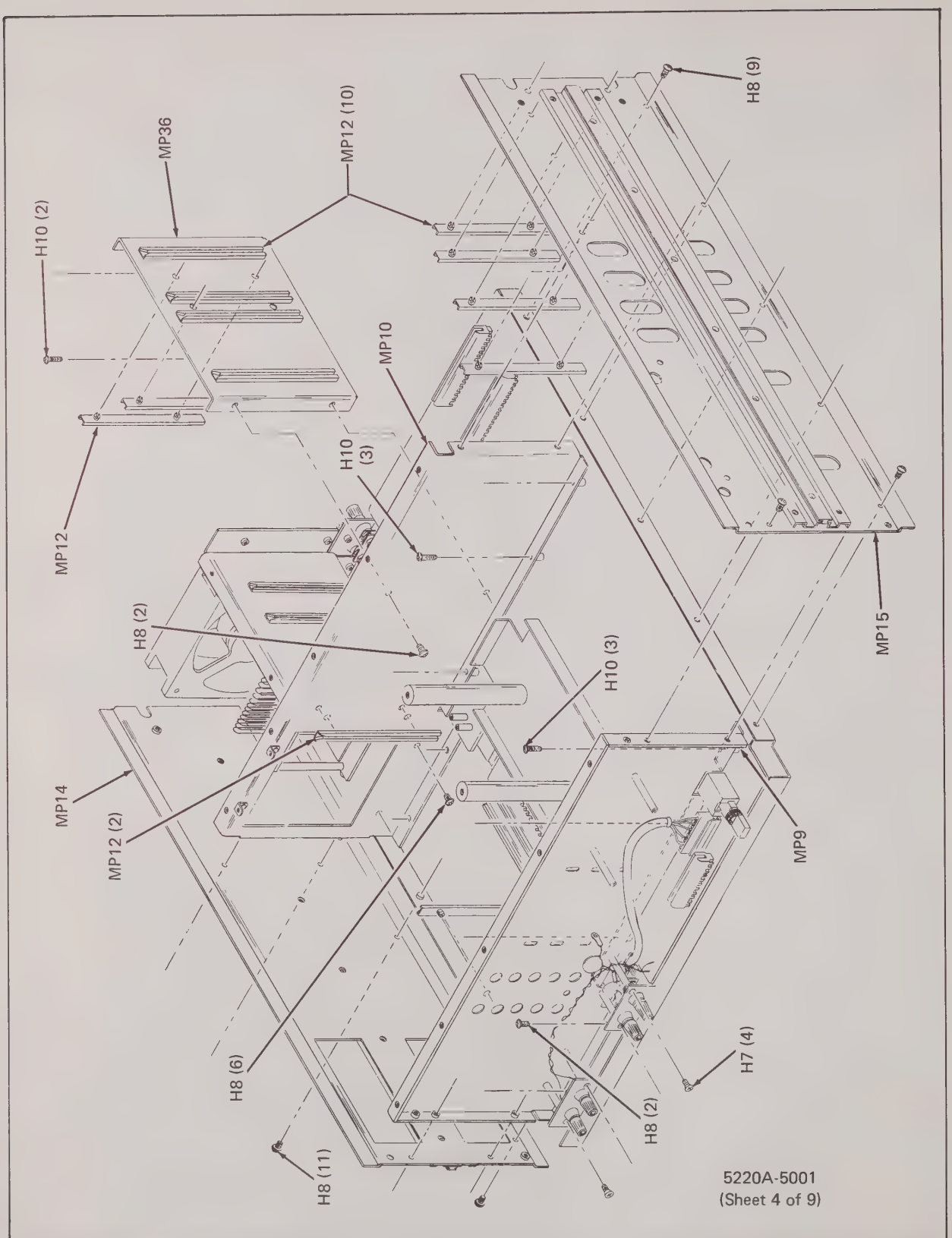


Figure 5-1. 5220A Final Assembly (cont)

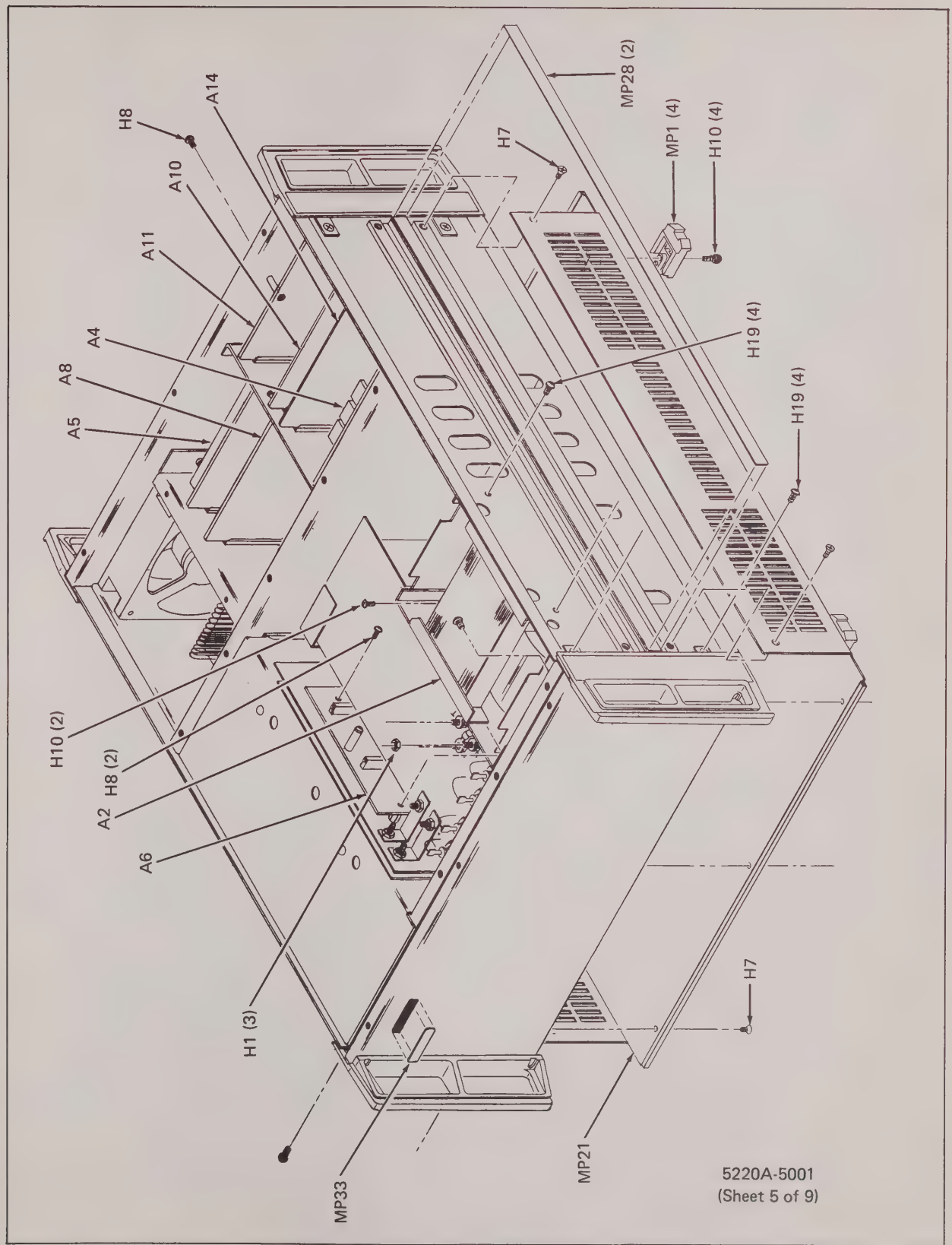


Figure 5-1. 5220A Final Assembly (cont)

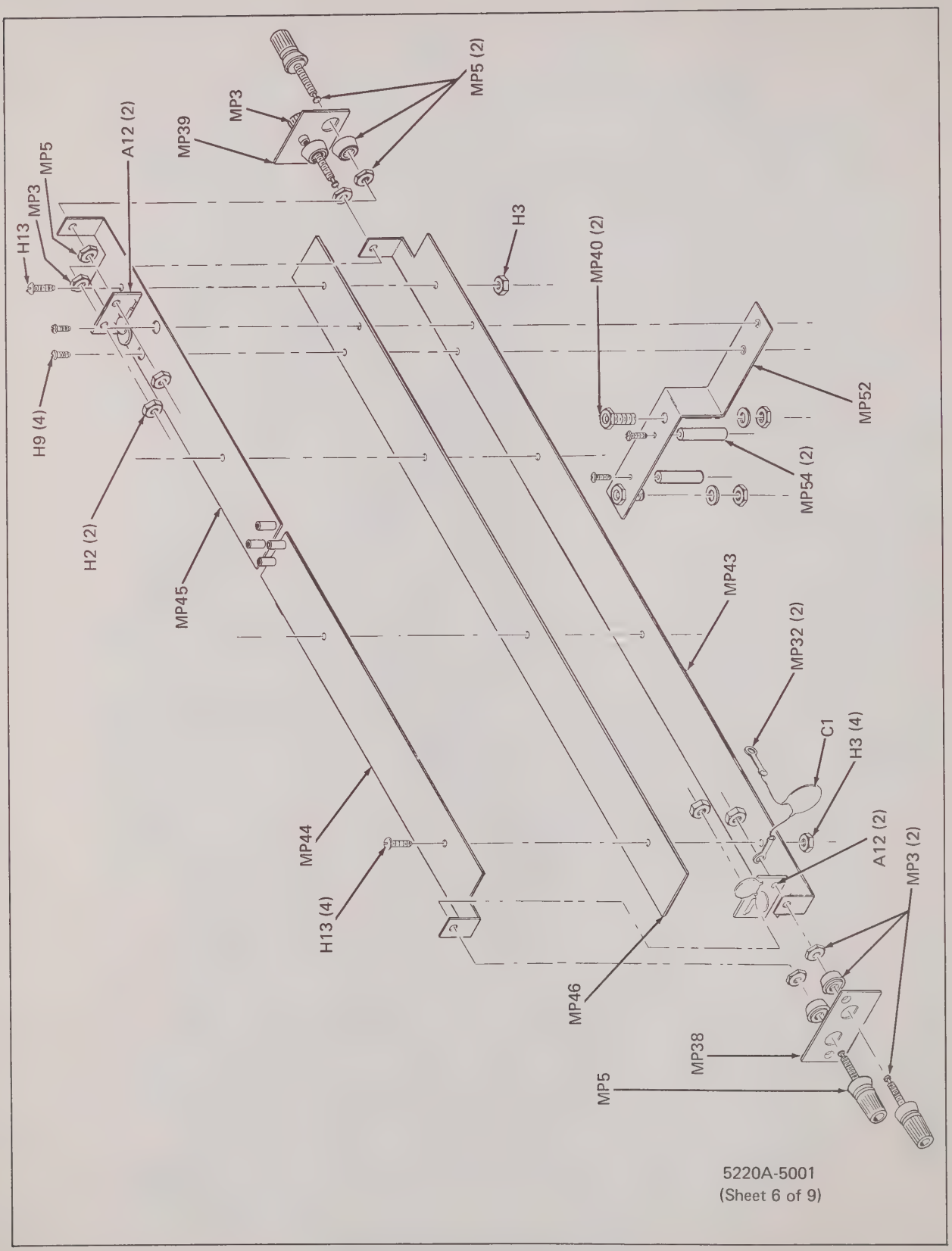


Figure 5-1. 5220A Final Assembly (cont)

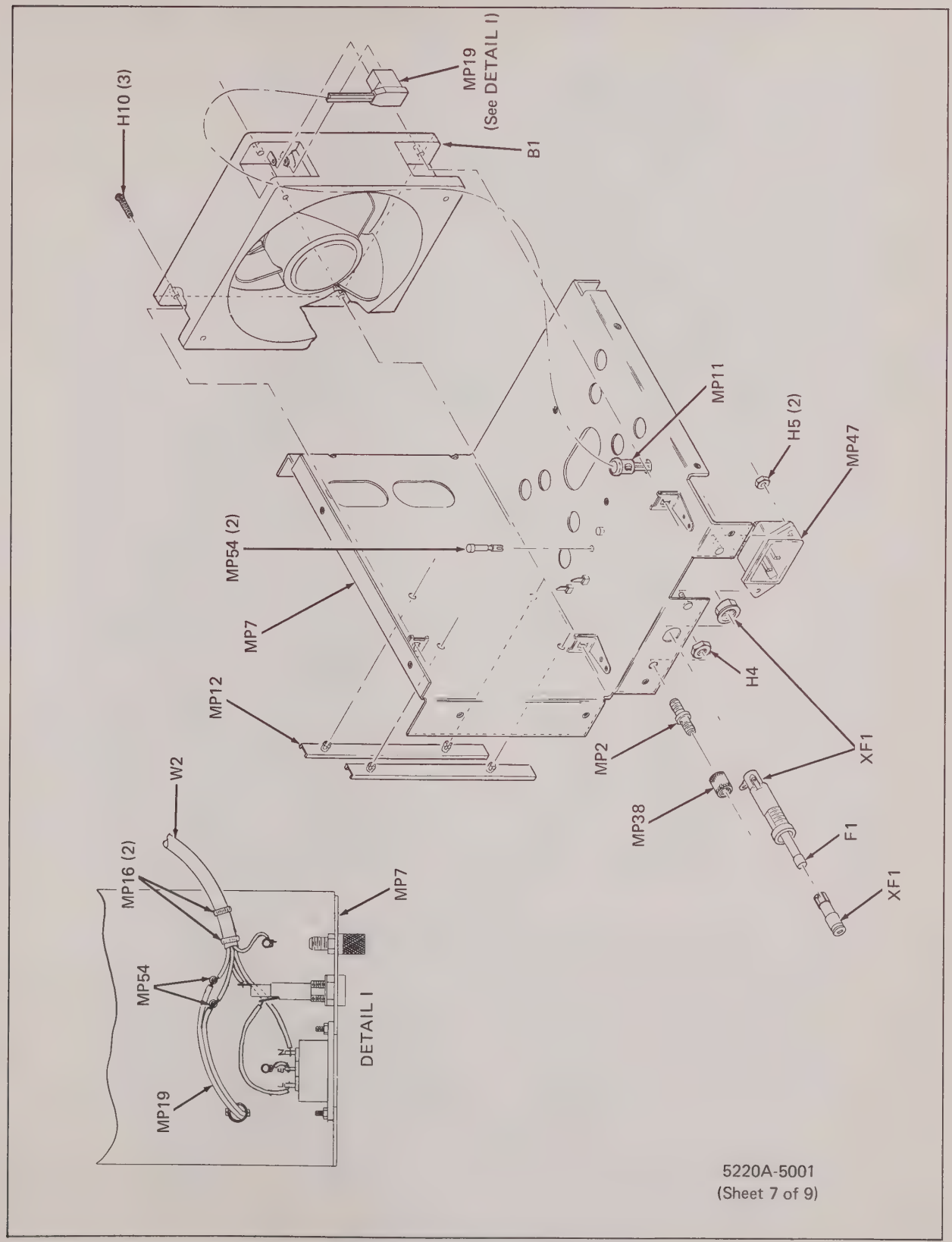


Figure 5-1. 5220A Final Assembly (cont)

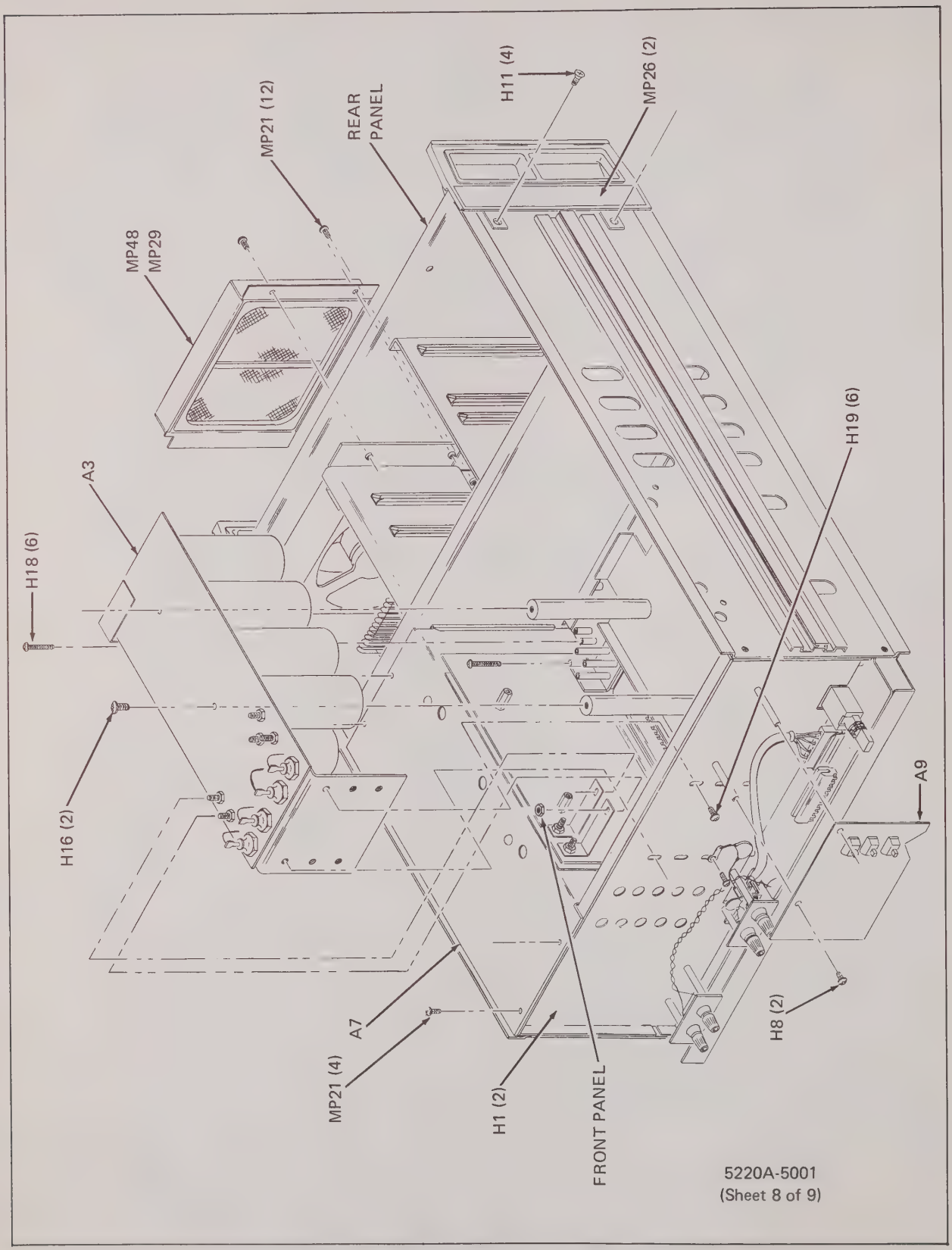


Figure 5-1. 5220A Final Assembly (cont)

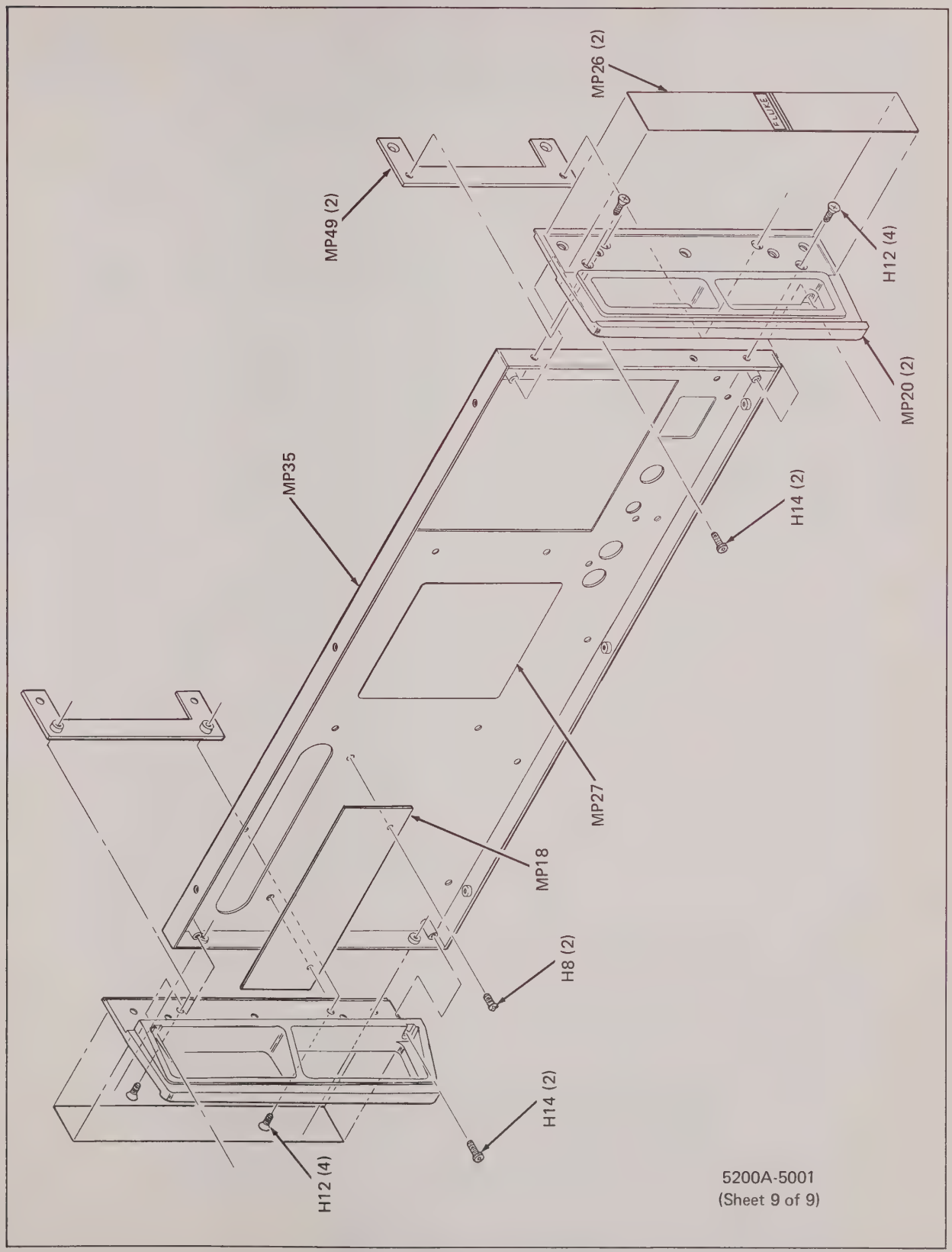


Figure 5-1. 5220A Final Assembly (cont)

Table 5-2. A1 Mother PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A1	MOTHER PCB ASSEMBLY FIGURE 5-2 (5220A-4001T)	491209	89536	491209	REF		
J1	CONTACT, 10-PIN	446724	27264	09-65-1101	1		
J10	CONNECTOR, RECEPT, 14-PIN	295352	00779	583650-9	2		
J20	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	7		
J30	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
J40	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
J50	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
J60	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
J70	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
J80	CONNECTOR, RECEPT, 28-PIN	459883	00779	1-583694-4	1		
J85	CONNECTOR, RECEPT, 24-PIN	295352	00779	583650-9	REF		
J90	CONNECTOR, RECEPT, 40-PIN	422550	00779	2-583407-0	REF		
MP1	CONNECTOR POST, (NOT SHOWN)	267500	00779	87022-1	4		
MP2	COVER, SWITCH (TO S4)	475681	89536	475681	1		
MP3	POLARIZING INSERT KEY	424572	00779	530286-2	19		
MP4	PUSHBUTTON, GREEN	419747	89536	419747	1		
MP5	BUSHING, SNAP (NOT SHOWN)	102996	28520	SB-375-4	2		
S4	SWITCH, POWER	453605	89536	453605	1		

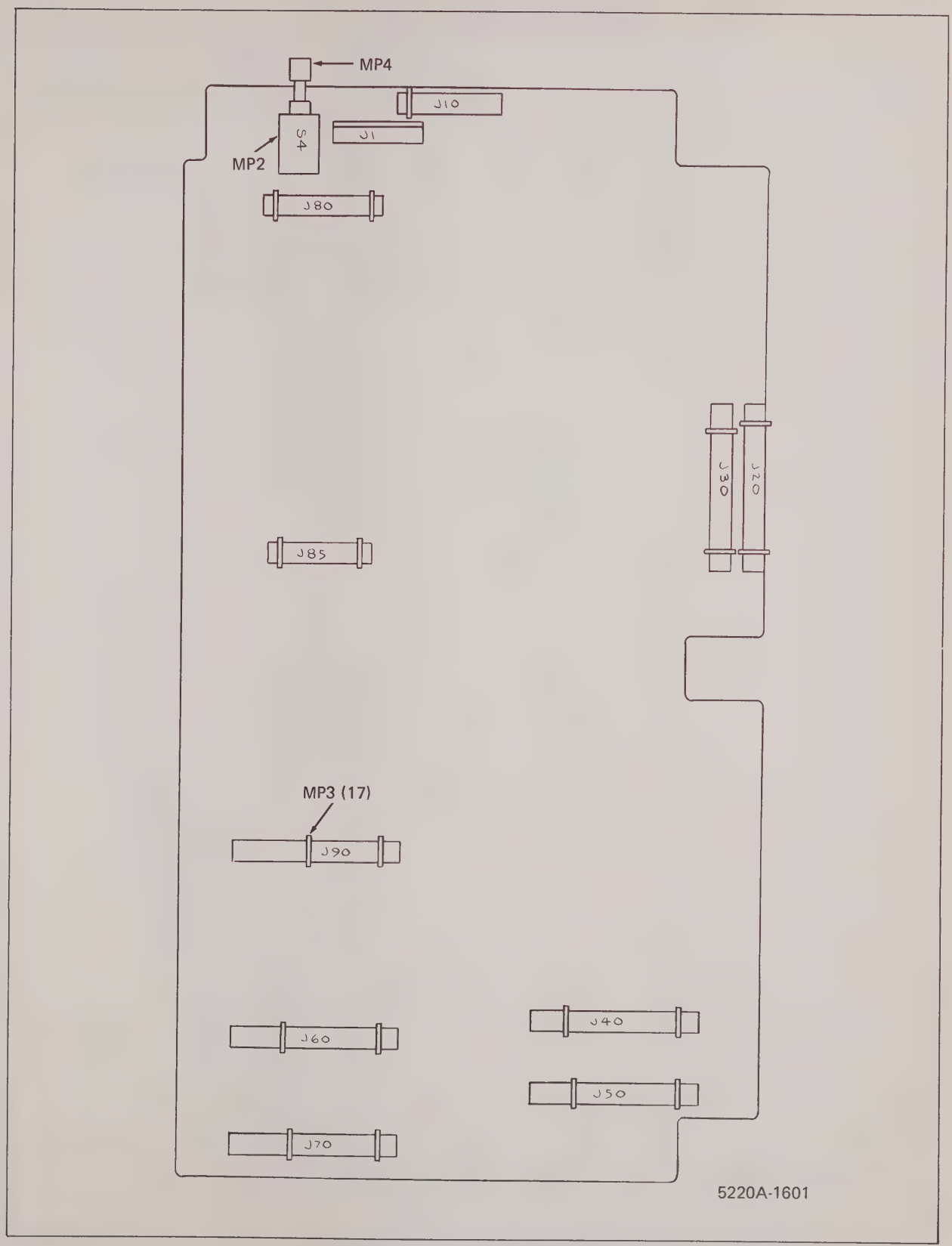


Figure 5-2. A1 Mother PCB Assembly

Table 5-3. A2 Power Transformer Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A2	POWER TRANSFORMER ASSEMBLY FIGURE 5-3 (5220A-4201T)	491282	89536	491282	REF		
F4	FUSE, SLO-BLO, 1/2 AMP	109322	71400	MDL1-2A	4	10	
F5	FUSE, SLO-BLO, 1/2 AMP	109322	71400	MDL1-2A	REF		
F6	FUSE, SLO-BLO, 1/2 AMP	109322	71400	MDL1-2A	REF		
F7	FUSE, SLO-BLO, 1/2 AMP	109322	71400	MDL1-2A	REF		
S1	SWITCH, SLIDE, DPDT	234278	82389	XW1649	3		
S2	SWITCH, SLIDE, DPDT	234278	82389	XW1649	REF		
S3	SWITCH, SLIDE, DPDT	234278	82389	XW1649	REF		
T1	TRANSFORMER, POWER	ORDER	A2	ASSEMBLY	1		
XF4-XF7	FUSE CLIP	485219	11503	3529	8		

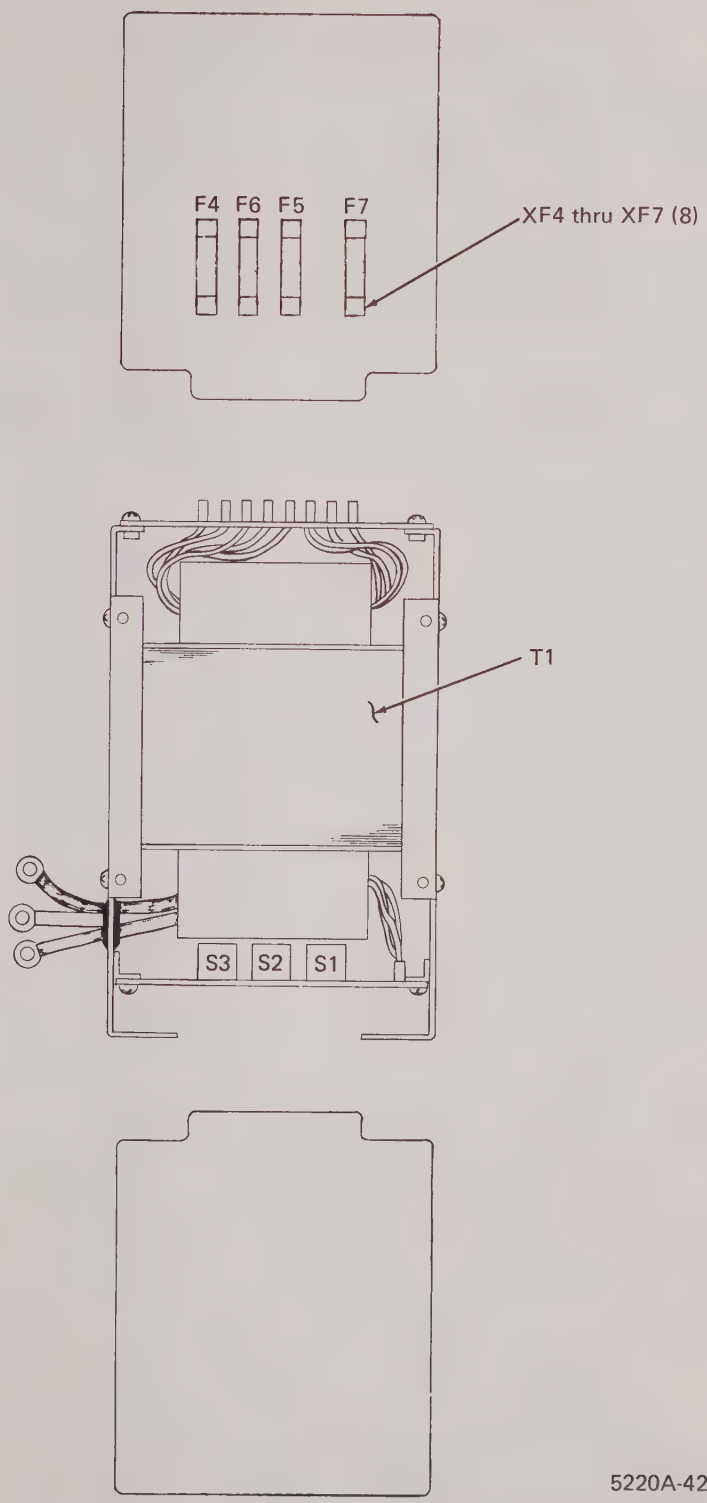


Figure 5-3. A2 Power Transformer Assembly

Table 5-4. A3 Capacitor Bus PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A3	CAPACITOR BUS PCB ASSEMBLY FIGURE 5-4 (5220A-5001-GP05)	ORDER	BY	REPLACEABLE PARTS	REF		
C1	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	8		
C2	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C3	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C4	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C5	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C6	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C7	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
C8	CAP, ELECT, 50,000 UF -10/+100, 15V	423525	56289	39DX503G015BC2B	REF		
CR1	DIODE, SI, RECTIFIER	483206	04713	1N248B	2	1	
CR2	DIODE, SI, RECTIFIER	483214	04713	1N248BR	2	1	
CR3	DIODE, SI, RECTIFIER	483206	04713	1N248B	REF		
CR4	DIODE, SI, RECTIFIER	483214	04713	1N248BR	REF		
F2	FUSE, FAST-ACT., 20 AMP	518860	71400	AGC20A	2	10	
F3	FUSE, FAST-ACT., 20 AMP	518860	71400	AGC20A	REF		
H1	NUT, HEX	110544	73734	8021NP	5		
H2	SCREW, PHP, 10-32 X 3/8	114314	73734	19084	16		
H3	SCREW, PHP, 8-32 X 1/2	159749	73734	19066	5		
H4	WASHER, FLAT (USED ON DIODES)	110718	73734	97335	4		
H5	WASHER, SHOULDER (USED ON DIODES)	110833	86928	5604-64	4		
H6	WASHER, MICA (USED ON DIODES)	500785	89536	500785	4		
MP1	FUSE CLIP	485219	11503	3529	4		
MP2	HEAT SINK (USED ON DIODES)	502179	89536	502179	1		
MP3	SHUNT BUS	497982	89536	497982	1		
R2	RES, COMP, 100 +/-10%, 2W	109934	01121	HB1011	2		
R5	RES, COMP, 100 +/-10%, 2W	109934	01121	HB1011	REF		

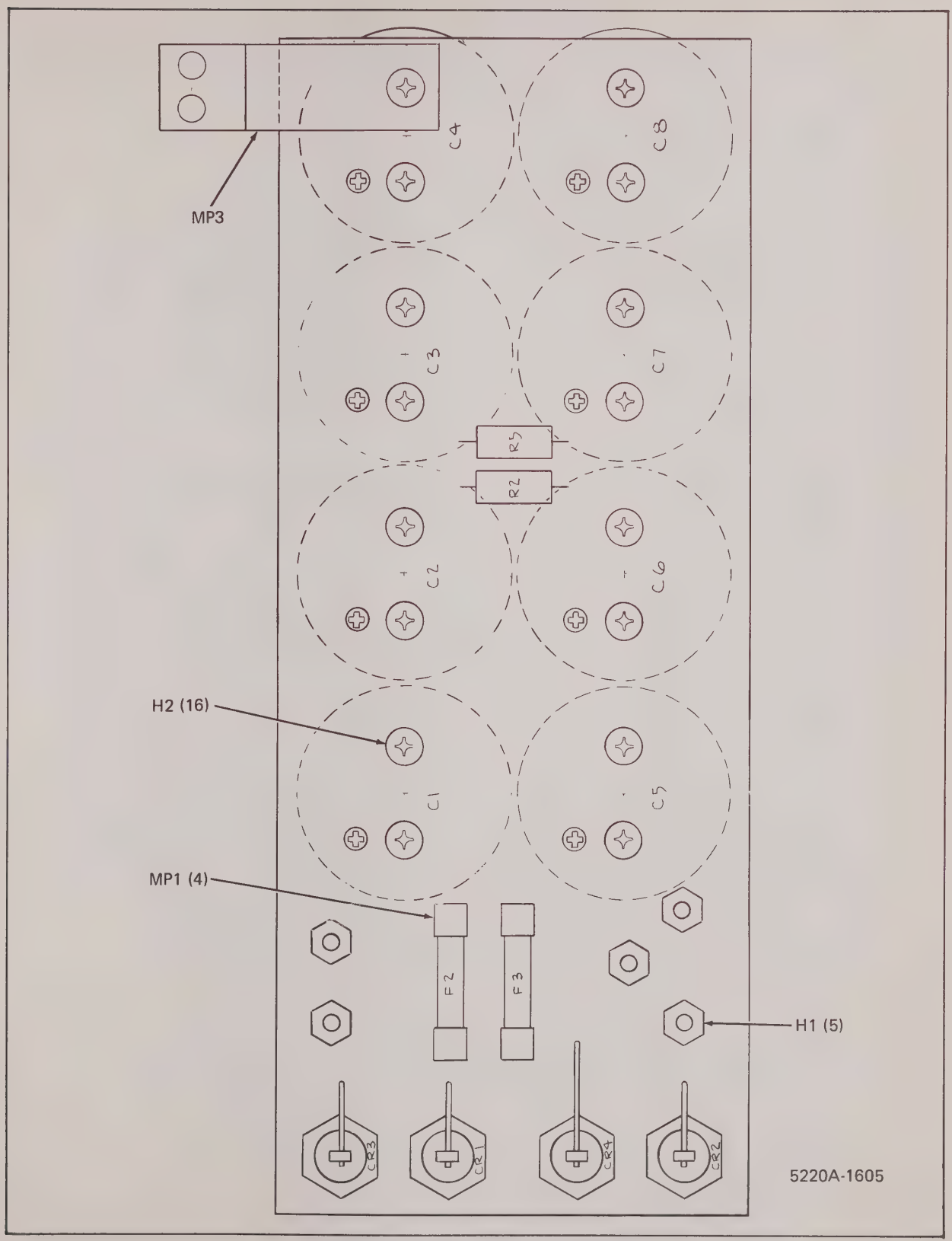


Figure 5-4. A3 Capacitor Bus PCB Assembly

Table 5-5. A4 Regulator PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A4	REGULATOR PCB ASSEMBLY FIGURE 5-5 (5220A-4090T)	489690	89536	489690	REF		
C9	CAP, ELECT, 4700 UF -10/+100, 15V	379370	80031	3050HJ472U015	4		
C10	CAP, ELECT, 4700 UF -10/+100, 15V	379370	80031	3050HJ472U015	REF		
C11	CAP, TA, 22 UF +/-20%, 25V	357780	56289	196D226X0025PE4	4		
C12	CAP, ELECT, 2200 UF -10/+100, 25V	392720	80031	3050HJ222U025	2		
C13	CAP, ELECT, 2200 UF -10/+100, 25V	392720	80031	3050HJ222U025	REF		
C14	CAP, TA, 22 UF +/-20%, 25V	357780	56289	196D226X0025PE4	REF		
C15	CAP, TA, 22 UF +/-20%, 25V	357780	56289	196D226X0025PE4	REF		
C16	CAP, ELECT, 4700 UF -10/+100, 15V	379370	80031	3050HJ472U015	REF		
C17	CAP, ELECT, 4700 UF -10/+100, 15V	379370	80031	3050HJ472U015	REF		
C18	CAP, TA, 22 UF +/-20%, 25V	357780	56289	196D226X0025PE4	REF		
CR5	DIODE, RECTIFIER	392910	09423	FB100	3	1	
CR6	DIODE, RECTIFIER	392910	09423	FB100	REF		
CR7	DIODE, RECTIFIER	392910	09423	FB100	REF		
CR8	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	2	1	
CR9	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
H1	NUT, HEX, 4-40	110635	73734	8003NP	4		
H2	SCREW, PHP, SEMS, 4-40 X 1/4	185918	89536	185918	4		
MP1	HEAT SINK	386235	13103	6032D	4		
MP2	HOLDER, RUBBER COMPONENT	104794	98159	2829-115-3	6		
R4	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	5		
R6	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R7	RES, COMP, 220 +/-10%, 1W	109462	01121	GB2211	2		
R8	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R9	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R10	RES, COMP, 1K +/-10%, 1W	109371	01121	GB1021	2		
R11	RES, COMP, 1K +/-10%, 1W	109371	01121	GB1021	REF		
R12	RES, COMP, 220 +/-10%, 1W	109462	01121	GB2211	REF		
R13	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	1		
R15	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
U1	IC, LINEAR, VOL REGULATOR	355107	12040	LM340T-5	2	1	
U2	IC, LINEAR, VOL REGULATOR	413187	12040	LM340T-15	1	1	
U3	IC, LINEAR, NEG VOL REGULATOR SERIES	413179	12040	LM7915T	1	1	
U4	IC, LINEAR, VOL REGULATOR	355107	12040	LM340T-5	REF		

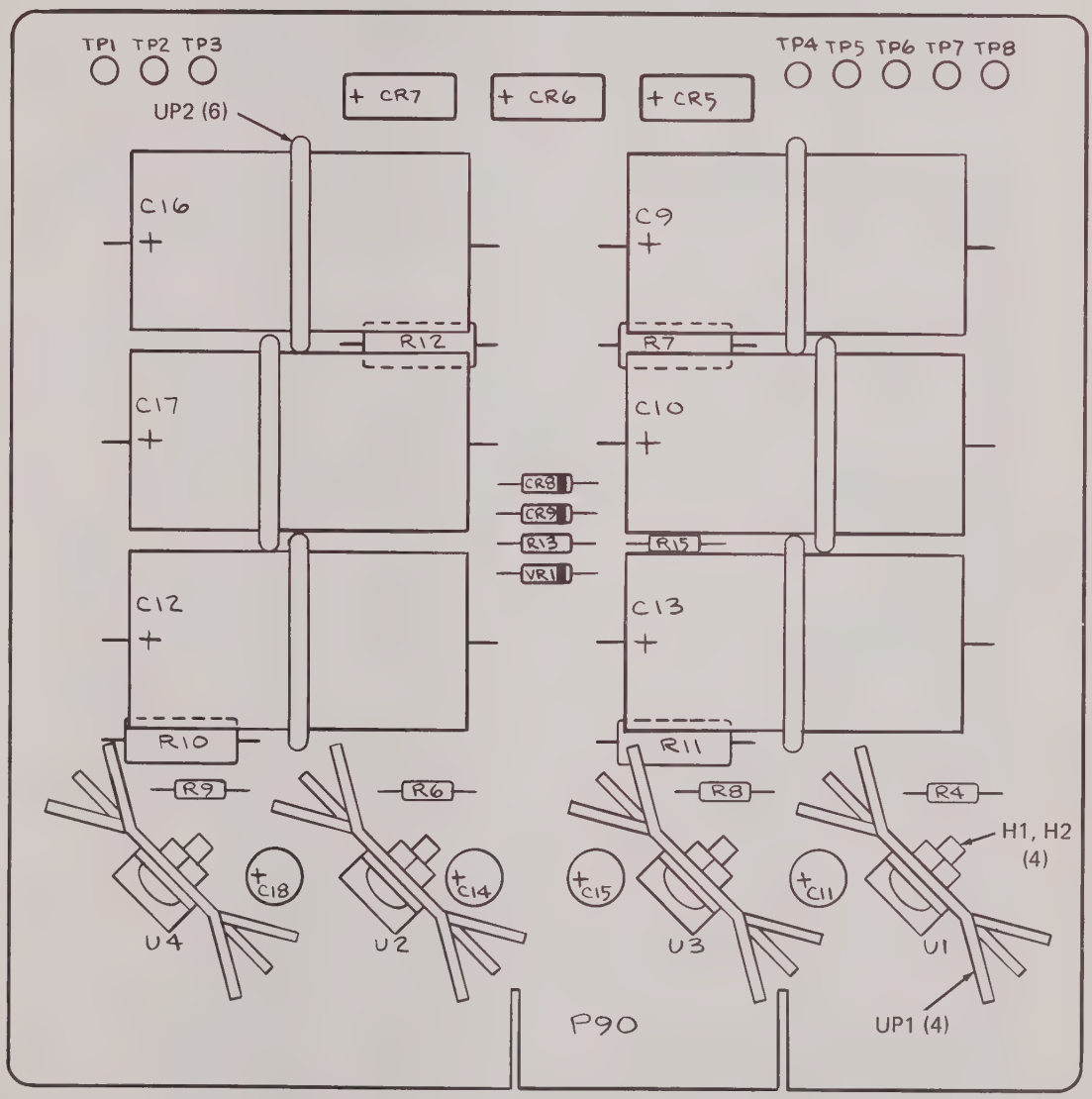


Figure 5-5. A4 Regulator PCB Assembly

Table 5-6. A5 Preamplifier PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A5	⊗ PRE-AMPLIFIER PCB ASSEMBLY FIGURE 5-6 (5220A-4050T)	487702	89536	487702	REF		
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	7		
C4	CAP, VAR, 5-50 PF, 250V	404301	56289	GKC50000	1		
C5	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C7	CAP, MICA, 3900 PF +/-5%, 500V	160325	72136	DM19F392J	1		
C8	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C11	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C12	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	1		
CR1	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	3	1	
CR2	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR3	DIODE, LO-CAP, LO-LEAK	375907	07263	FD7222	3		
CR4	DIODE, LO-CAP, LO-LEAK	375907	07263	FD7222	REF		
CR6	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
H1	SCREW, PHP SEMS, 6-32 X 1/4 (ON MP1)	178533	89536	178533	4		
K1	RELAY, DRY REED	424408	89536	424408	2		
K2	RELAY, DRY REED	424408	89536	424408	REF		
MP1	SHIELD, PRE-AMP, (NOT SHOWN)	486001	89536	486001	1		
Q1	XSTR, FET, N-CHANNEL	393314	21845	F2799	1	1	
Q2	XSTR, DUAL, NPN	478099	12040	LM3940M	1	1	
Q3	XSTR, SI, NPN	329698	07263	2N2484	1	1	
Q4	XSTR, FET, N-CHANNEL	404277	01295	TIS-73	1	1	
R1	RESISTOR SET (R1, R2)	502625	89536	502625	1	1	
R2	RESISTOR (PART OF R1 SET)				REF		
R3	RES, VAR, CER, 500 +/-20%, 1/2W	267849	11236	190PC501B	1	1	
R4	RES, MTL. FILM, 60.4K +/-1%, 1/8W	291419	91637	CMF556042F	1		
R5	RESISTOR SET (R5, R7)	502617	89536	502617	1	1	
R6	RES, VAR, CER, 2K +/-20%, 1/2W	267864	11236	190PC202B	1	1	
R7	RESISTOR (PART OF R5 SET)				REF		
R8	RES, MTL. FILM, 215K +/-1%, 1/8W	289470	91637	CMF552153F	1		
R9	RES, MTL. FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R10	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R14	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R15	RES, MTL. FILM, 1.27K +/-1%, 1/8	267369	91637	CMF551271F	1		
R16	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	CMF551002F	1		
R17	RES, DEP. CAR, 10 +/-5%, 1/4W	340075	80031	CR251-4-5P10E	2		
R18	RES, DEP. CAR, 10 +/-5%, 1/4W	340075	80031	CR251-4-5P10E	REF		
R19	RES, MTL. FILM, 422 +/-1%, 1/8W	288506	91637	CMF554220F	1		
R20	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R21	RES, DEP. CAR, 1K, +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R22	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R23	RES, DEP. CAR, 1K, +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R24	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	1		
U1	IC, LINEAR, 5-XSTR ARRAY	248906	12040	LM3046N	1	1	

Table 5-6. A5 Preamplifier PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U2	IC, LINEAR OP-AMP	429837	12040	LF3561T	1	1	
U3	OPTO-ISOLATOR	507475	89536	507475	1	1	
U4	Ⓢ IC, C-MOS, HEX, BUFFER/INVERTERS	381848	02735	CD4049AE	1	1	

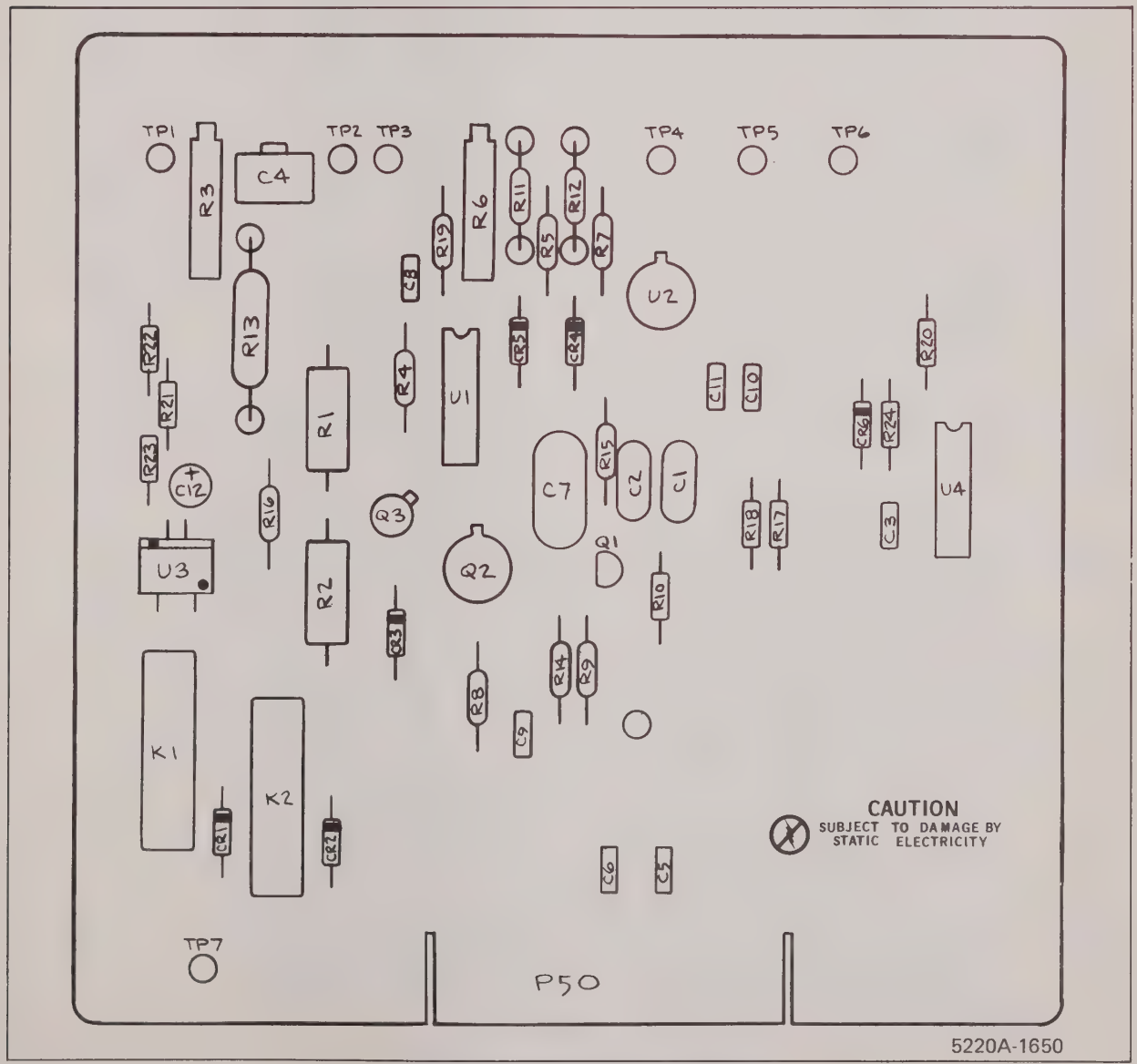


Figure 5-6. A5 Preamplifier PCB Assembly

Table 5-7. A6 Driver PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A6	DRIVER PCB ASSEMBLY FIGURE 5-7 (5220A-4030T)	491233	89536	491233	REF		
C1	CAP, PLYSTR, 0.027 UF +/-10%, 250V	267120	73445	C280MAE/A27K1	1		
C2	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	2		
C3	CAP, CER, 180 PF +/-10%, 1000V	105890	56289	C023B102E181M	2		
C4	CAP, CER, 180 PF +/-10%, 1000V	105890	56289	C023B102E181M	REF		
C5	CAP, CER, 0.005 UF +/-20%, 100V	175232	56289	C023B101E502M	1		
C6	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	1		
C7	CAP, CER, 0.1 UF +/-20%, 100V	149146	56289	33C41B6	1		
CR1	DIODE, FET CURRENT REG 5.2 MA	334714	07910	TCR5315	1	1	
CR2	DIODE, H-SPEED SWITCH	203323	07910	1N4448	1	1	
MP1	SPACER, XSTR	152207	07047	10123DAP	5		
Q1	XSTR, SI, PNP	229898	89536	229898	1	1	
Q2	XSTR, SI, NPN	218081	04713	MPS6520	3	1	
Q3	XSTR, SI, NPN	218081	04713	MPS6520	REF		
Q4	XSTR, SI, NPN	218081	04713	MPS6520	REF		
Q5	XSTR, SI, PNP	402586	04713	2N2905A	3	1	
Q6	XSTR, FET, N-CHANNEL	261578	89536	261578	3	1	
Q7	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q8	XSTR, SI, NPN	346916	89536	346916	2	1	
Q9	XSTR, SI, PNP	402586	04713	2N2905A	REF		
Q10	XSTR, SI, PNP	402586	04713	2N2905A	REF		
Q11	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q12	XSTR, SI, NPN	346916	89536	346916	REF		
R1	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	3		
R2	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R3	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R4	RES, MTL. FILM, 523 +/-1%, 1/8W	294835	91637	CMF555320F	2		
R5	RES, MTL. FILM, 523 +/-1%, 1/8W	294835	91637	CMF555320F	REF		
R6	RES, VAR, CER, 10 +/-20%, 1/2W	344135	11236	190PC100B	1	1	
R7	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	2		
R8	RES, MTL. FILM, 191 +/-1%, 1/8W	325639	91637	CMF551910F	1		
R9	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	2		
R10	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R12	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R13	RES, VAR, CER, 100 +/-20%, 1/2W	267823	11236	190PC101B	1	1	
R14	RES, MTL. FILM, 604 +/-1%, 1/8W	320309	91637	CMF556040F	2		
R15	RES, MTL. FILM, 383 +/-1%, 1/8W	375899	91637	CMF553830F	1		
R16	RES MTL. FILM, 604 +/-1%, 1/8W	320309	91637	CMF556040F	REF		
R17	RES, MTL. FILM, 953 +/-1%, 1/8W	288555	91637	CMF559530F	1		
R18	RES, MTL. FILM, 100 +/-1%, 1/8W	168195	91637	CMF551000F	2		
R19	RES, DEP. CAR, 51 +/-5%, 1/4W	414540	80031	CR251-4-5P51E	2		
R20	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R21	RES, MTL. FILM, 33.2 +/-1%, 1/8W	296681	91637	CMF553320F	2		
R22	RES, MTL. FILM, 33.2 +/-1%, 1/8W	296681	91637	CMF553320F	REF		
R23	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R24	RES, MTL. FILM, 100 +/-1%, 1/8W	168195	91637	CMF551000F	REF		
R25	RES, DEP. CAR, 51 +/-5%, 1/4W	414540	80031	CR251-4-5P51E	REF		
R26	RES, MTL. FILM, 20 +/-1%, 1/8W	236844	91637	CMF550200F	2		
R27	RES, MTL. FILM, 20 +/-1%, 1/8W	236844	91637	CMF550200F	REF		

Table 5-7. A6 Driver PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R28	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	2		
R29	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	REF		
R30	RES, COMP, 10 +/-10%, 1/2W	108092	01121	EB1001	2		
R31	RES, COMP, 10 +/-10%, 1/2W	108092	01121	EB1001	REF		
VR1	DIODE, ZENER, 4.3V	180455	07910	1N749A	2		
VR2	DIODE, ZENER, 4.3V	180455	07910	1N749A	REF		

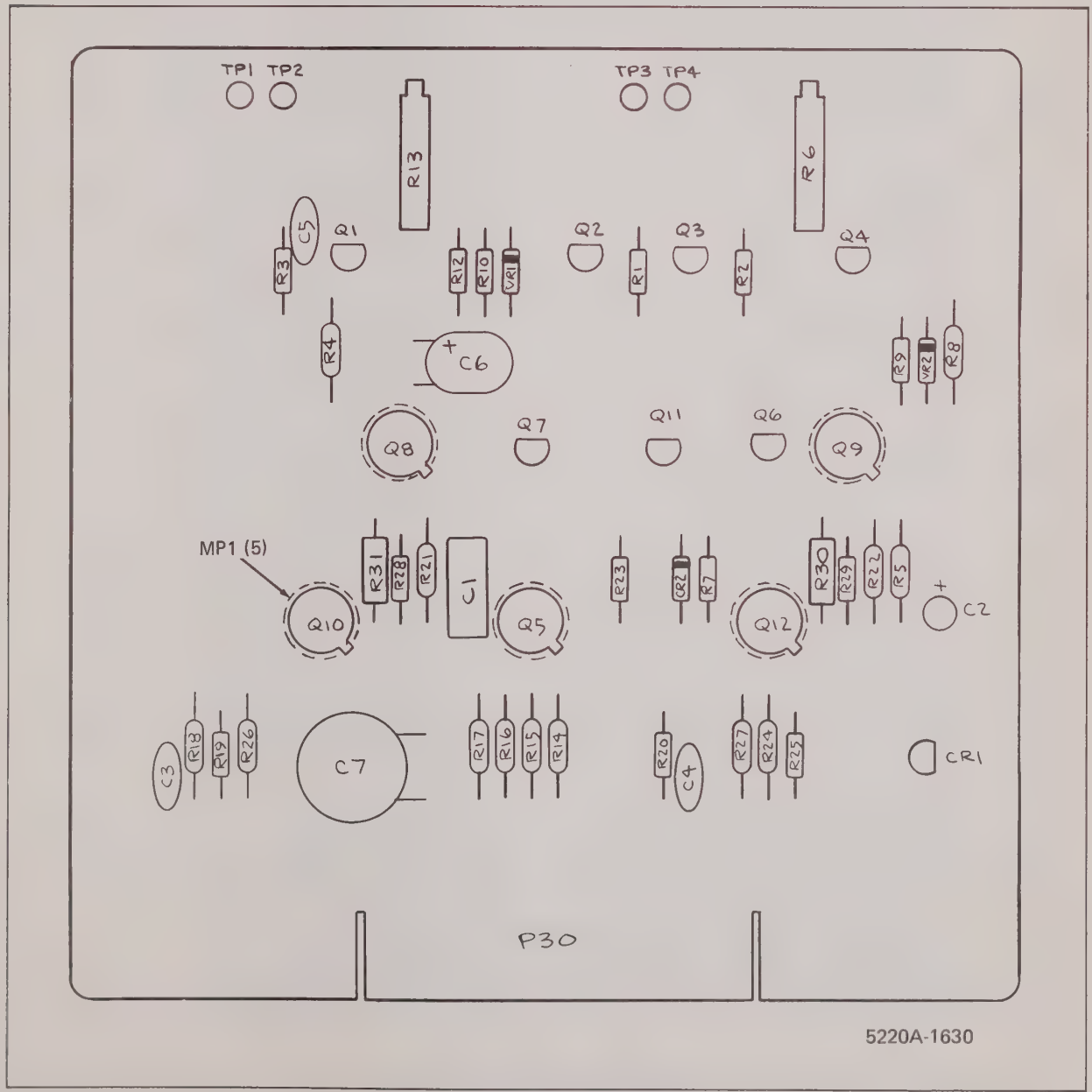


Figure 5-7. A6 Driver PCB Assembly

Table 5-8. A7 Output PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A7	OUTPUT PCB ASSEMBLY FIGURE 5-8 (5220A-4020T)	491225	89536	491225	REF		
H1	NUT HEX, 8-32 (NOT SHOWN)	110544	73734	8009NP	2		
H2	NUT, HEX, 6-32	110551	73734	8006NP	1		
H3	NUT, HEX, 4-40	147611	89536	147611	2		
H4	SCREW, PHP, 4-40 X 5/16	152116	73734	18023	2		
H5	SCREW, PHP, 4-40 X 3/8	152124	73734	18024	2		
H6	SCREW, PHP, 6-32 X 1/4	152140	73734	18042	2		
H7	SCREW, PHP, 8-32 X 3/8	114124	73734	19064	8		
H8	SCREW, PHP, 6-32 X 3/4	114223	73734	19048	8		
H9	LOCKWASHER, INT. TOOTH #6	110338	73734	1304	1		
H10	LOCKWASHER, INT. TOOTH #4	110403	73734	1302	2		
MP1	STANDOFF, CONNECTOR (NOT SHOWN)	348201	02660	10022-2	8		
MP2	DEFLECTOR, FIN	489518	89536	489518	1		
MP3	HEATSINK, FIN	489880	89536	489880	1		
MP4	HEATSINK, W/BEO WASHER	407262	13103	1130	1		
MP5	HOLE PLUG	187799	89536	187799	2		
MP6	INSULATOR, XSTR	477802	13103	4703A	4		
MP7	OUTPUT BUS	502161	89536	502161	2		
MP8	OUTPUT BRACKET	489567	89536	489567			
MP9	OUTPUT CHAMBER	485961	89536	485961			
MP10	PLATE, TEMP SENSE	489898	89536	489898			
MP11	PAD, XSTR MTG	152207	07047	10123-DAP			
MP12	SPACER, #6	215210	89536	215210	1		
Q101	XSTR, SI, PNP W/MICA WSHR, (TO MP9)	325753	09214	D45C5	1	1	
Q102	XSTR, SI, PNP W/MICA WSHR, (TO MP9)	325761	09212	D44C5	1	1	
Q103	XSTR, SI, PNP, (TO MP9)	483222	01295	2N5883	2	1	
Q104	XSTR, SI PNP, (TO MP9)	483222	01295	2N5883	REF		
Q105	XSTR, SI, NPN, (TO MP9)	483230	01295	2N5885	2	1	
Q106	XSTR, SI, NPN, (TO MP9)	483230	01295	2N5835	REF		
Q107	XSTR, SI, PNP (TO MP9)	402586	01295	2N2905A	1	1	
R101	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	7		
R102	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R103	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R104	RES, DEP. CAR 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R105	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R106	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R107	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R108	RES, COMP, 5.1 +/-5%, 1/2W	177147	01121	EB51G5	2		
R109	RES, COMP, 5.1 +/-5%, 1/2W	177147	01121	EB51G5	REF		
R110	RES 4 TERM, 0.086 +/-1%, 1CW	490771	89536	490771	4	1	
R111	RES, 4 TERM, 0.086 +/-1%, 10W	490771	89536	490771	REF		
R112	RES, 4 TERM, 0.086 +/-1%, 10W	490771	89536	490771	REF		
R113	RES, 4 TERM, 0.086 +/-1%, 10W	490771	89536	490771	REF		
R114	RES, WW, 2.4 +/-5%, 2W (ON CIRCUIT SIDE)	219337	89536	219337	2	1	
R115	RES, WW, 2.4 +/-5% 2W, (ON CIRCUIT SIDE)	219337	89536	219337	REF		
S101	THERMOSTAT, MINI, SPST, (ON MP9)	344002	89536	344002	1		
XQ101	SOCKET, XSTR	402958	0992	DIL28P-108	2		
XQ102	SOCKET, XSTR	402958	0992	DIL28P-108	REF		

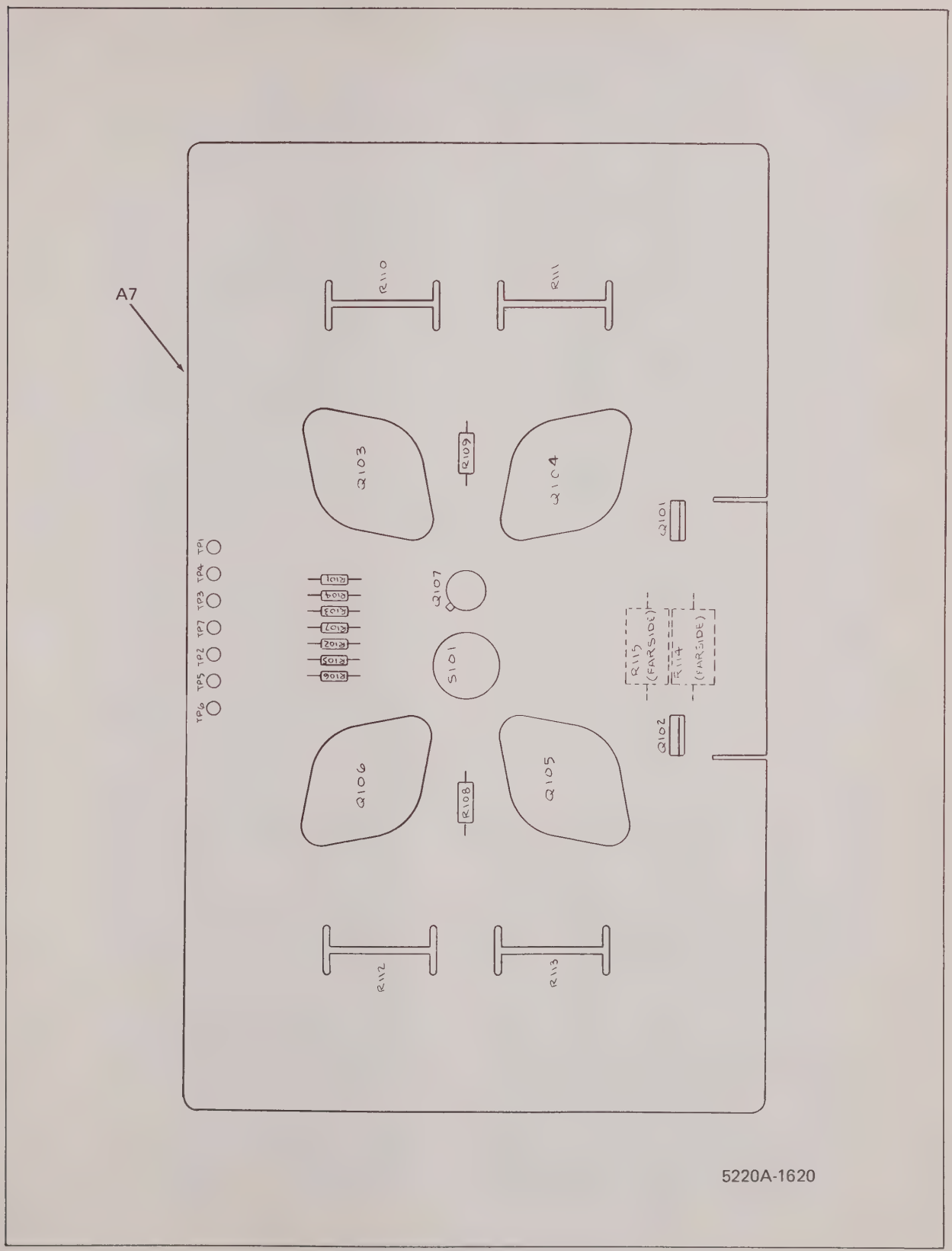


Figure 5-8. A7 Output PCB Assembly

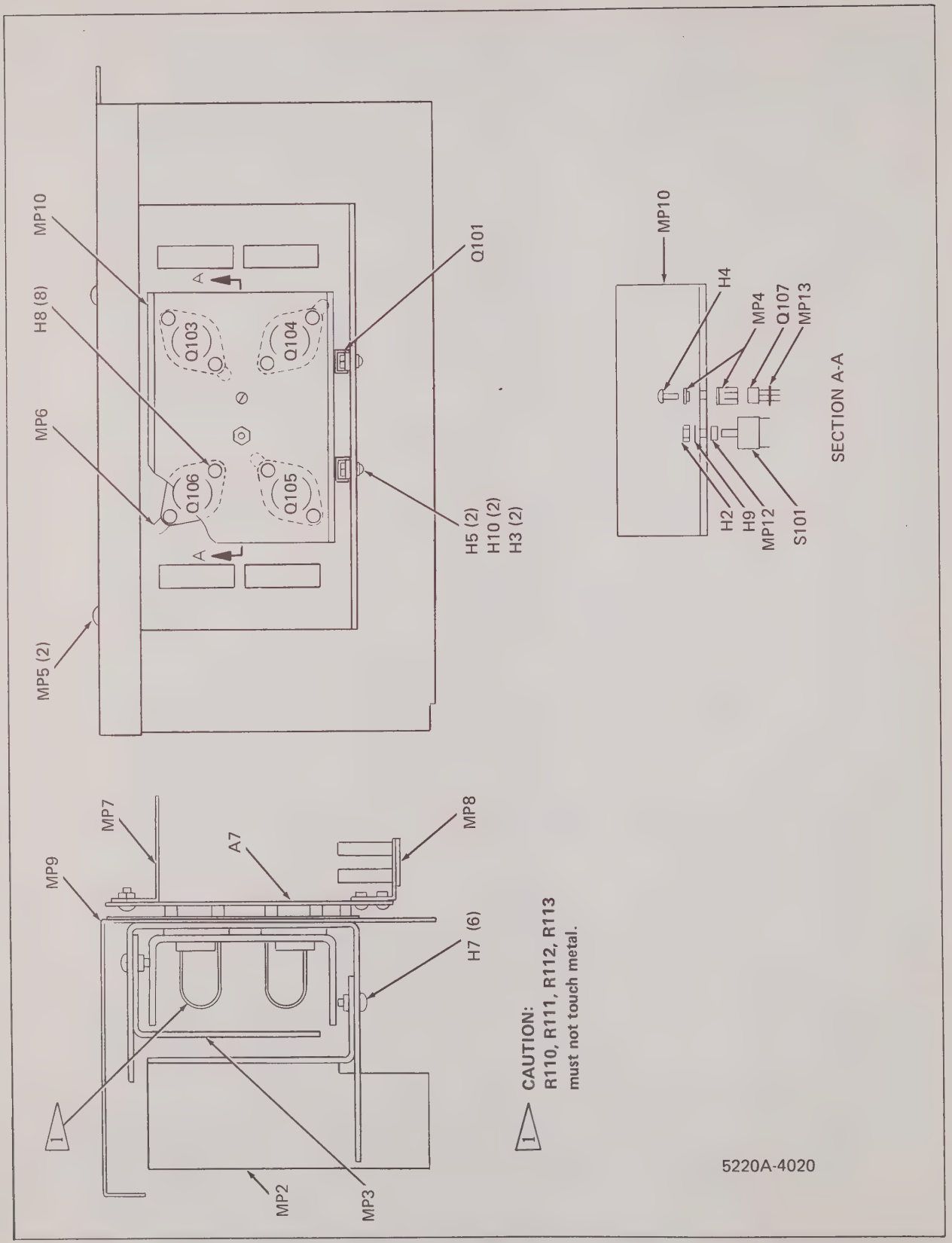


Figure 5-8. A7 Output PCB Assembly (cont)

Table 5-9. A8 Analog Control PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A8	ANALOG CONTROL PCB ASSEMBLY FIGURE 5-9 (5220A-4040T)	491241	89536	491241	REF		
C1	CAP, CER, 180 PF +/-10%, 1000V	105890	56289	C023B102E181M	1		
C2	CAP, POLYFILM, 0.22 UF +/-10%, 100V	436113	80031	C280MAH/A220K	1		
C3	CAP, ELECT, TA, 0.68 UF +/-110%, 35V	182790	56289	150D684X9035A2	1		
CR1	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	10	3	
CR2	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR3	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR4	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR5	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR6	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR7	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR8	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR9	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR10	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR11	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	1	1	
Q1	XSTR, SI, PNP	195974	04713	2N3906	2	1	
Q2	XSTR, SI, NPN	218396	04713	2N3904	2	1	
Q3	XSTR SI, PNP	195974	04713	2N3906	REF		
Q4	XSTR, SI, NPN	218396	04713	2N3904	REF		
R1	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	2		
R2	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	REF		
R3	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	1		
R4	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	11		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	12		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP. CAR, 82K +/-5%, 1/4W	348912	80031	CR251-4-5P82K	1		
R9	RES, VAR, CER, 100K +/-10%, 1/2W	288308	89536	288308	1	1	
R10	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R11	RES, DEP. CAR, 300K +/-5%, 1/4W	441535	80031	CR251-4-5P300K	1		
R12	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	3		
R13	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	CMF551002F	2		
R14	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	CMF551002F	REF		
R15	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	REF		
R16	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R18	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R19	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R20	RES, DEP CAR, 9.1K +/-5%, 1/4W	441691	80031	CR251-4-5P9K1	1		
R21	RES, VAR, CER, 5K +/-10%, 1/2W	288282	89536	288282	1		
R22	RES, DEP. CAR, 1.1K +/-5%, 1/4W	348797	80031	CR251-4-5P1K1	1		
R23	RES, DEP. CAR, 390K +/-5%, 1/4W	442475	80031	CR251-4-5P390K	1		
R24	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	REF		
R25	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R26	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	2		
R27	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R28	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R29	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		

Table 5-9. A8 Analog Control PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R30	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	REF		
R31	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R32	RES, DEP. CAR, 10K +/-5%, 1	348839	80031	CR251-4-5P10K	REF		
R33	RES, DEP. CAR, 2K +/-5%, 1/4W	441378	80031	CR251-4-5P1K2	1		
R35	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R36	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R37	RES, DEP. CAR 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R38	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R39	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R40	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R41	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R42	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R43	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
U1	IC, LINEAR, OP-AMP	402669	12040	LM324N	2	1	
U2	IC, LINEAR, OP-AMP	402669	12040	LM324N	REF		
U3	IC TTL, SCHMITT TRIG, POS NAND GATES	483180	01295	SN74LS14N	1	1	
VR1	DIODE, ZENER	187195	07910	C036554	2	1	
VR2	DIODE, ZENER	187195	07910	C036554	REF		

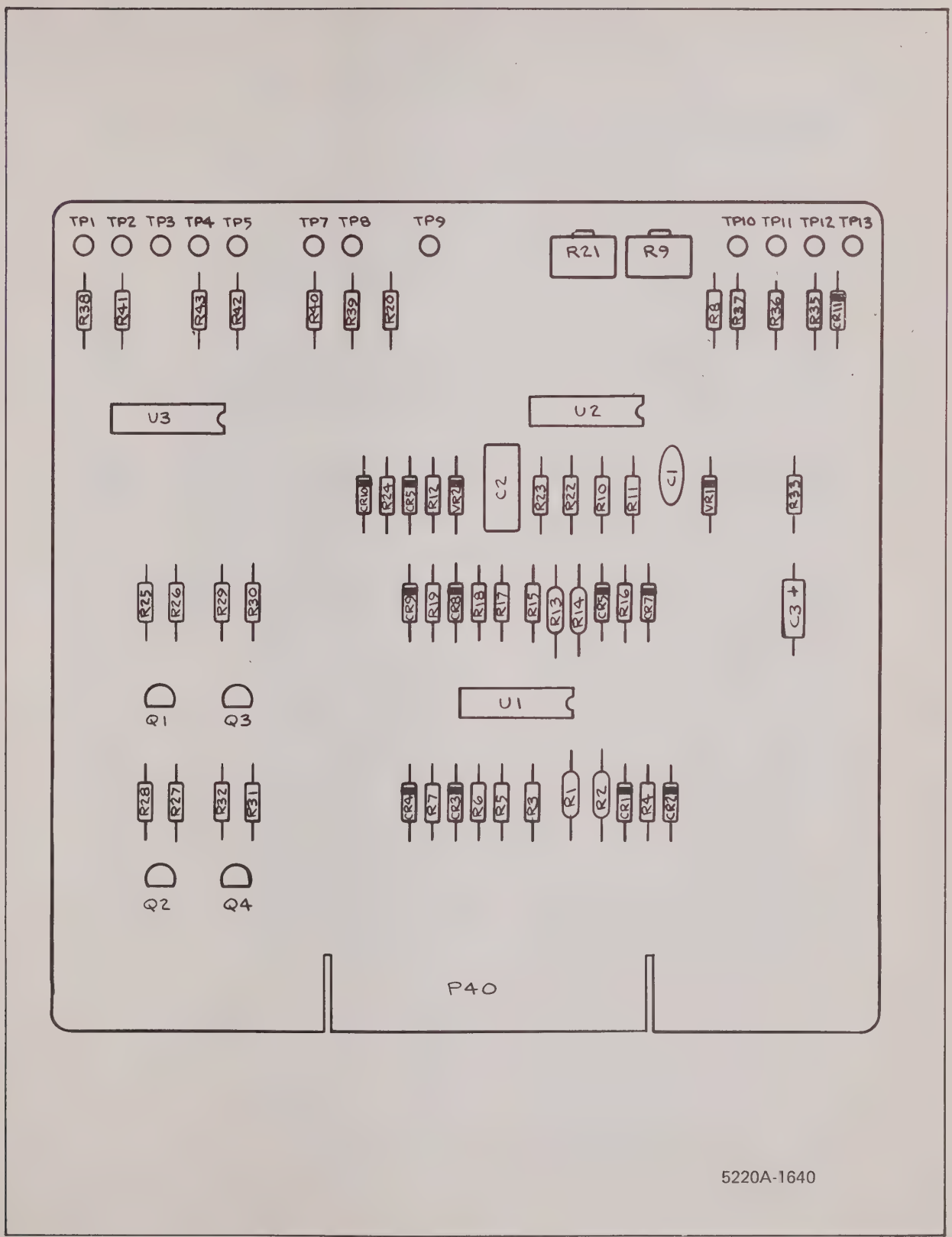
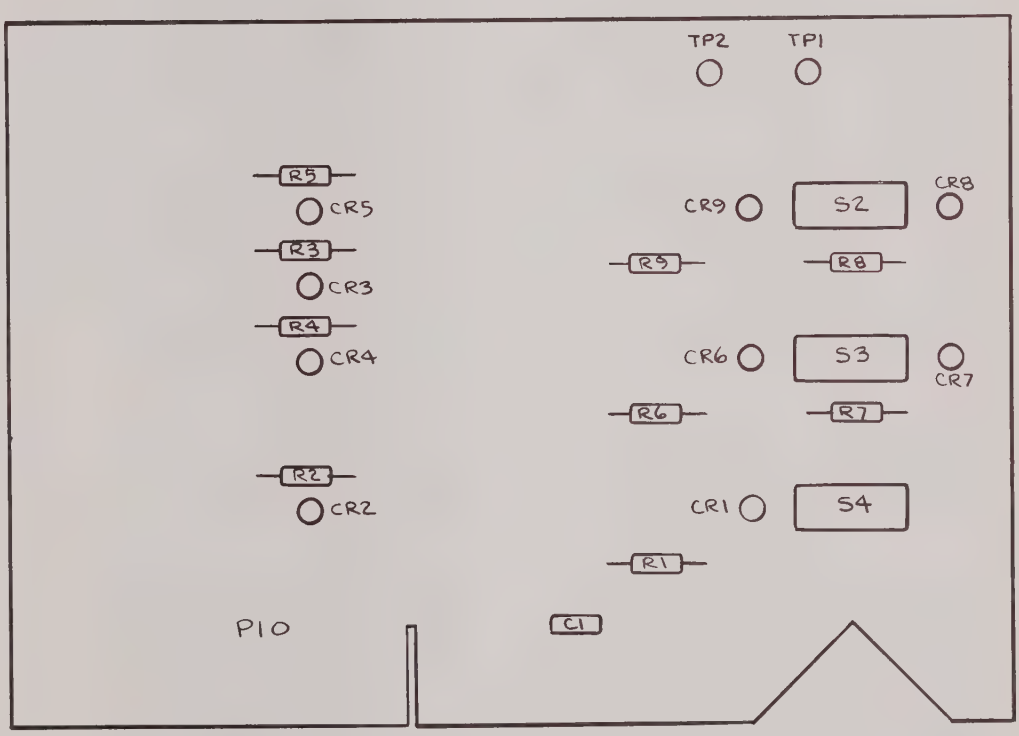


Figure 5-9. A8 Analog Control PCB Assembly

Table 5-10. A9 Front Panel PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A9	FRONT PANEL PCB ASSEMBLY FIGURE 5-10 (5220A-4010T)	491217	89536	491217	REF		
C1	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
CR1	DIODE, LIGHT EMITTING	369777	28480	5082-4480	9	2	
CR2	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR3	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR4	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR5	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR6	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR7	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR8	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
CR9	DIODE, LIGHT EMITTING	369777	28480	5082-4480	REF		
R1	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	9		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R3	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R4	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R5	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R6	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R7	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R8	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R9	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
S2	SWITCH ASSEMBLY	ORDER	ITEMS	SEPARATE, AS FOLLOWS			
	ACTUATOR, SWITCH	412106	89536	412106	3		
	CONTACT, FIXED	416875	00779	62380-4	3		
	COVER, SWITCH	401299	89536	401299	3		
	PUSH BUTTON, LIGHT GRAY	406728	89536	406728	3		
	SPRING, SWITCH	414516	00779	62353-3	3		
S3	SWITCH ASSEMBLY	ORDER	ITEMS	SEPARATE, AS FOLLOWS	REF		
	ACTUATOR, SWITCH	412106	89536	412106	REF		
	CONTACT, FIXED	416875	00779	62380-4	REF		
	COVER, SWITCH	401299	89536	401299	REF		
	PUSH BUTTON, LIGHT GRAY	406728	89536	406728	REF		
	SPRING, SWITCH	414516	00779	62353-3	REF		
S4	SWITCH ASSEMBLY	ORDER	ITEMS	SEPARATE, AS FOLLOWS	REF		
	ACTUATOR, SWITCH	412106	89536	412106	REF		
	CONTACT, FIXED	416875	00779	62380-4	REF		
	COVER, SWITCH	401299	89536	401299	REF		
	PUSH BUTTON, LIGHT GRAY	406728	89536	406728	REF		
	SPRING, SWITCH	414516	00779	62353-3	REF		



5220A-1610

Figure 5-10. A9 Front Panel PCB Assembly

Table 5-11. A10 Logic PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A10	Ⓧ LOGIC PCB ASSEMBLY FIGURE 5-11 (5220A-4060T)	491258	89536	491258	REF		
C1	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	3		
C2	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D476X0025KA1	1		
C3	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	REF		
C4	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	REF		
C5	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D226X0020HA1	1		
C6	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D106X0035JA1	4		
C7	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D106X0035JA1	REF		
C8	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D106X0035JA1	REF		
C9	CAP, TA, 22 UF +/-20%, 16V	423012	56289	196D227X0016KA1	1		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	5		
C11	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C12	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C14	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C15	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023101F103M	1		
C16	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D106X0035JA1	REF		
CR1	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	3	1	
CR2	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR3	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
R1	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	7		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	13		
R4	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R7	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R10	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R13	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	3		
R14	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R15	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R16	RES, DEP. CAR 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R18	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R19	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R20	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R21	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R22	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R23	RES, DEP. CAR 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	2		
R24	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R25	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R26	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
U1	OPTO-ISOLATOR, LOGIC DRIVE	387076	29083	MCT6	4	1	
U2	Ⓧ IC, C-MOS, QUAD 2-IN NAND, SCHMITT TRIG	404632	02735	CD4039BE	1	1	

Table 5-11. A10 Logic PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U3	⊗IC C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U4	OPTO-ISOLATOR, LOGIC DRIVE	387076	29083	MCT6	REF		
U5	OPTO-ISOLATOR, LOGIC DRIVE	387076	29083	MCT6	REF		
U6	⊗IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U7	⊗IC, C-MOS, DUAL "D" F/F	418830	12040	MM74C74	2	1	
U8	⊗IC, C-MOS, DUAL, RTRG/RSTBL MONO/MLTVBR	393512	02735	CD4098AE	2	1	
U9	⊗IC, COS-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4001AE	1	1	
U10	⊗IC, C-MOS, DUAL "D" F/F	418830	12040	MM74C74	REF		
U11	⊗IC, C-MOS, DUAL, RTRG/RSTBL MONO/MLTVBR	393512	02735	CD4098AE	REF		
U12	IC QUAD, 2-INPUT POS/NAND BUFFER	393116	01295	SN74LS37N	3	1	
U13	IC, QUAD, 2-INPUT POS/NAND BUFFER	393116	01295	SN74LS37N	REF		
U14	IC, QUAD, 2-INPUT POS/NAND BUFFER	393116	01295	SN74LS37N	REF		
U15	IC, DUAL PERIPHERAL DRIVER	329706	01295	SN75452P	1	1	
U16	⊗IC, C-MOS, DUAL "D" TYPE F/F	340117	04713	MC14013CP	2	1	
U17	⊗IC, C-MOS, DUAL "D" TYPE F/F	340117	04713	MC14013CP	REF		
U19	⊗IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	REF		
U20	OPTO-ISOLATOR, LOGIC DRIVE	387076	29083	MCT6	REF		
U21	⊗IC, C-MOS, TRIPLE 3-INPUT OR GATE	408575	02735	CD4075BE	1	1	
U22	IC, MSI, LO-PWR SCHTKY 4-BIT SHFT/RGSTR	393249	01295	SN74LS194N	1	1	
U23	IC, LINEAR TIMER	402610	12040	LM555CN	1	1	
XU23	SOCKET, IC, 8-PIN	478016	91506	308-AG39D	1		

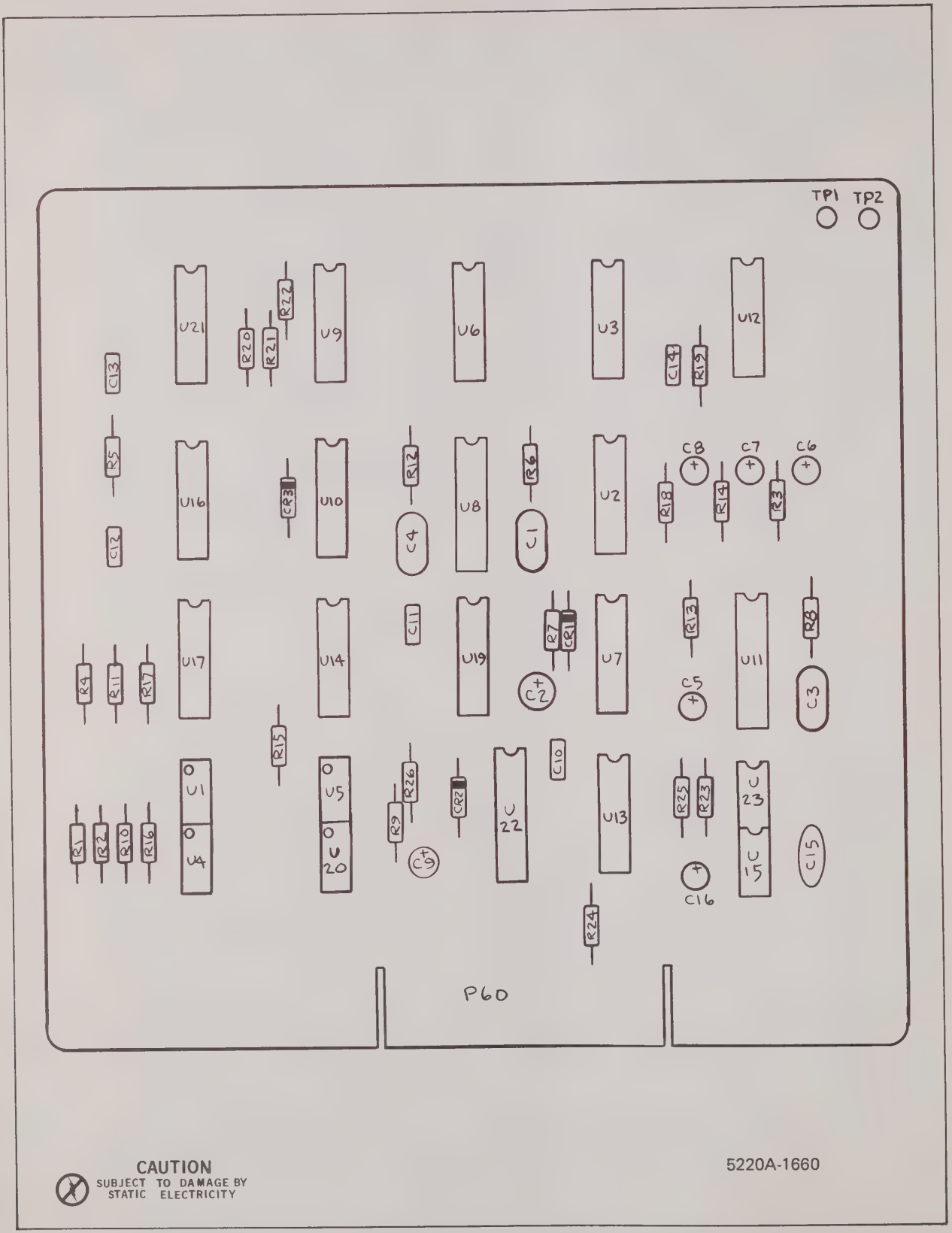


Figure 5-11. A10 Logic PCB Assembly

Table 5-12. A11 MIS Bus Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A11	Ⓐ MIS BUS INTERFACE PCB ASSEMLY FIGURE 5-12 (5220A-4070T)	491266	89536	491266	REF		
C1	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D476X0025KA1	1		
C2	CAP, TA, 22 UF +/-20%, 16V	423012	56289	196D220X0016KA1	1		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	2		
C4	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	1		1
H1	SCREW, SEMS, 4-40 X 1/4	185918	89536	185918	2		
J71	CONNECTOR ASSEMBLY	ORDER	ITEMS	SEPARATE, AS FOLLOWS			
	CONNECTOR, FEMALE, 24-PIN	441337	02660	57-20240-8	1		
	CONNECTOR MTG LATCH	412700	71785	422-22-11-015	2		
	SPRING, CONNECTOR	412718	71785	436-99-22-205	2		
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	12		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R10	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R14	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	9		
R15	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R16	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R17	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R18	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R19	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R20	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R21	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R22	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R23	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
U1	Ⓐ IC, C-MOS, QUAD "D" F/F	452912	12040	MM74C175N	1		1
U2	IC, TTL, POS NAND GATES AND INVERTERS	394205	01295	SN74LS03N	2		1
U3	Ⓐ IC, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1		1
U4	Ⓐ IC, C-MOS, QUAD 2-INPUT NAND GATE	418509	12040	MM74C00N	1		1
U5	Ⓐ IC, C-MOS, TRIPLE 3-INPUT NAND GATE	418244	12040	MM74C10N	1		1
U6	IC QUAD, 2-INPUT POS/NAND BUFFER	393116	01295	SN74LS37N	1		1
U7	IC TTL, POS NAND GATES AND INVERTERS	394205	01295	SN74LS03N	REF		

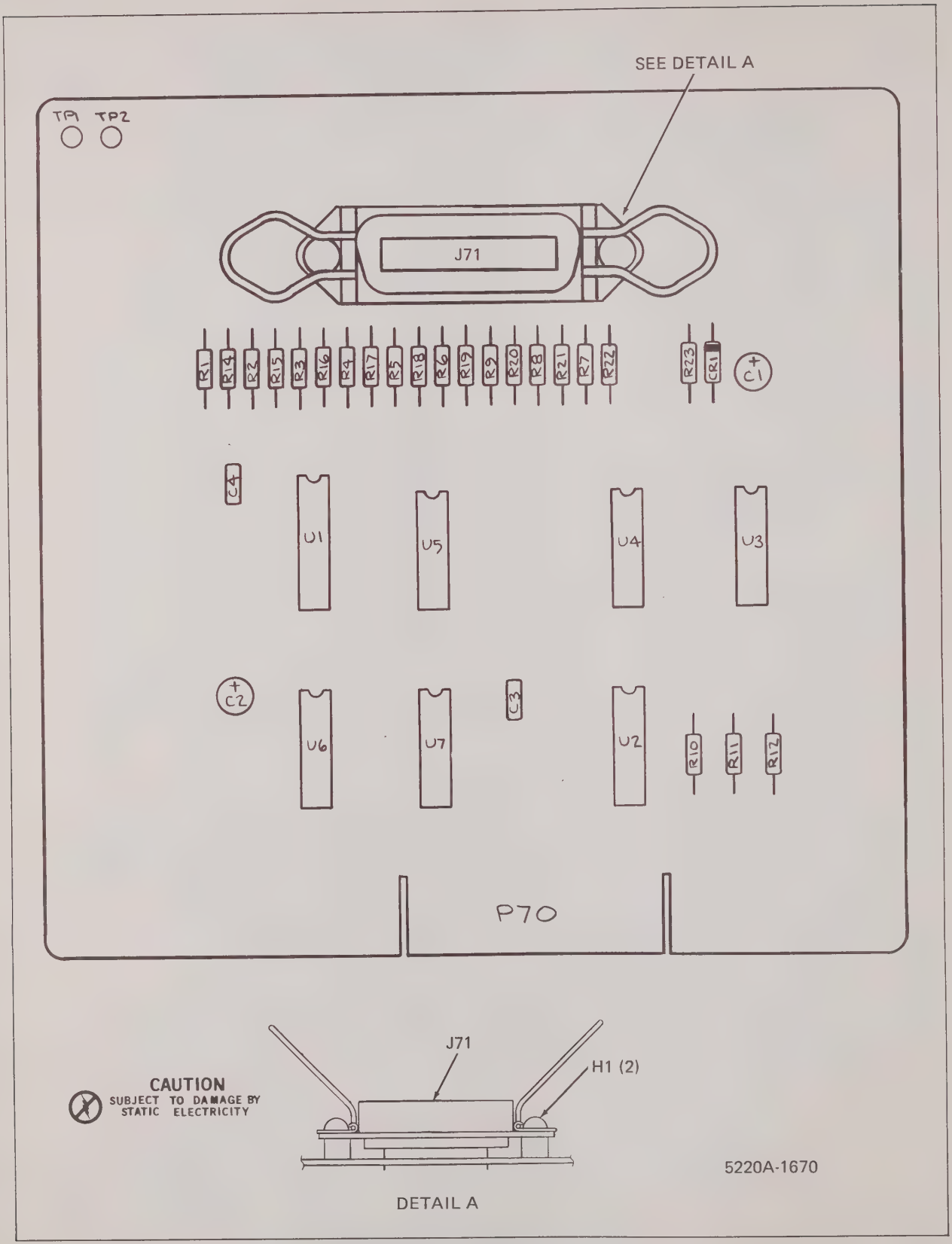


Figure 5-12. A11 MIS Bus PCB Assembly

Table 5-13. A12 Shunt Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A12	SHUNT ASSEMBLY FIGURE 5-13 (5220A-4202)	491290	89536	491290	1	1	
	NON-REPARABLE ASSEMBLY						

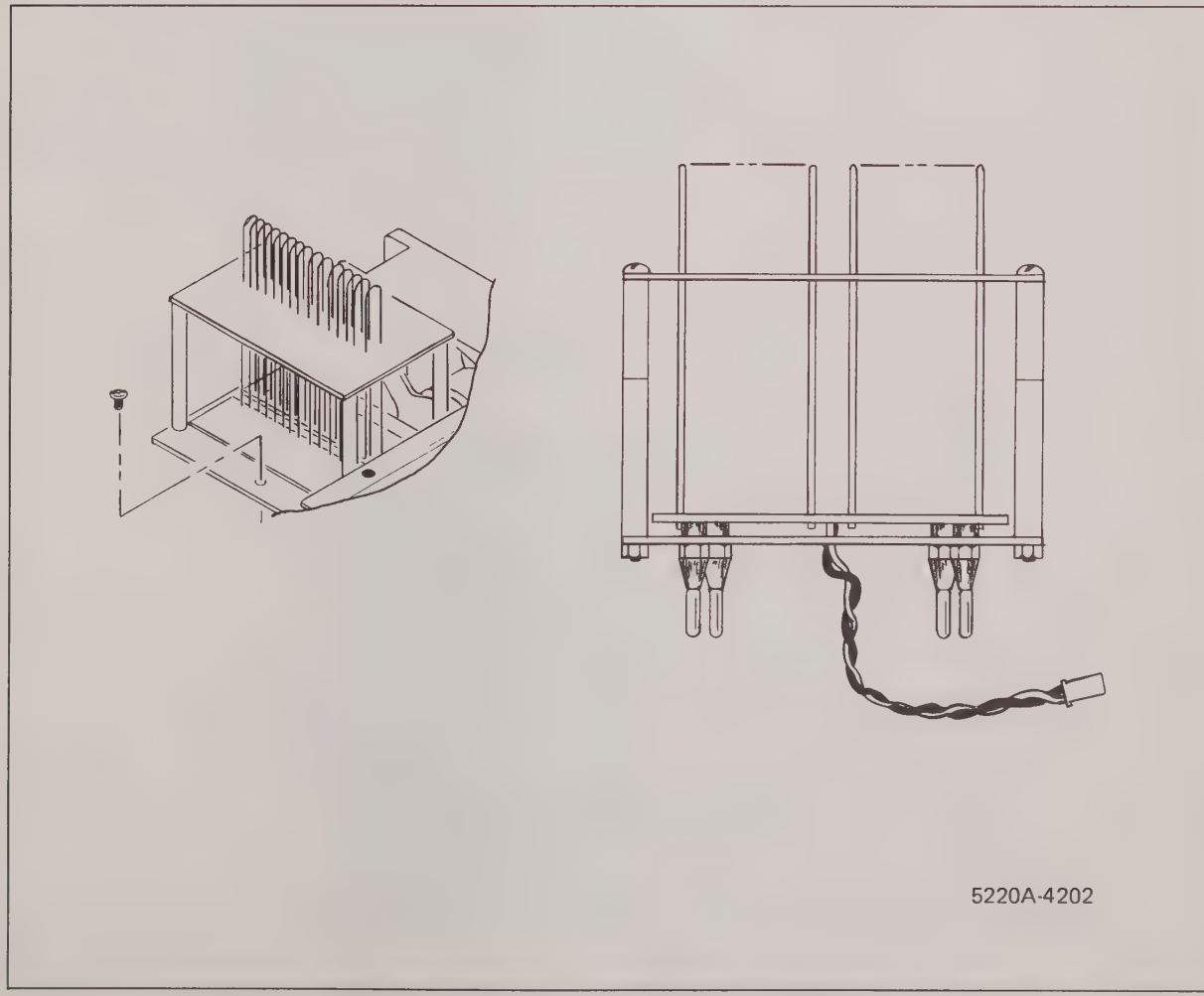
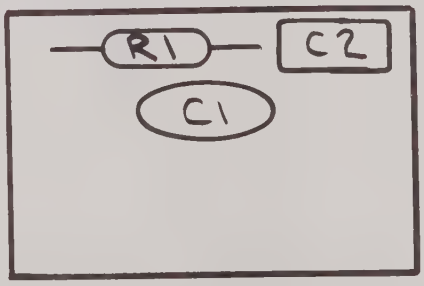


Figure 5-13. A12 Shunt Assembly

Table 5-14. A13 Output Terminal PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A13	OUTPUT TERMINAL PCB ASSEMBLY FIGURE 5-14 (5220A-4004)	491274	89536	491274	REF		
C1	CAP, CER 0.025 UF +/-20%, 100V	168435	56289	C023B101H253M	1		
C2	CAP, CER, 0.1 +/-GMV, 50V	369199	71590	U1-50-103	1		
R1	RES, MTL. FILM, 40.2 +/-1%, 1/8W	245373	91637	CMF554020F	1		



5220A-1604

Figure 5-14. A13 Output Terminal PCB Assembly

Table 5-15. A14 Extender PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A14	EXTENDER PCB ASSEMBLY FIGURE 5-15 (5220A-4003) (USED FOR PCB MAINTENANCE. ONE (1) EXTENDER BOARD IS SUPPIED WITH EACH UNIT. MAY BE ORDERED SEPARATELY.)	486217	89536	486217	1		

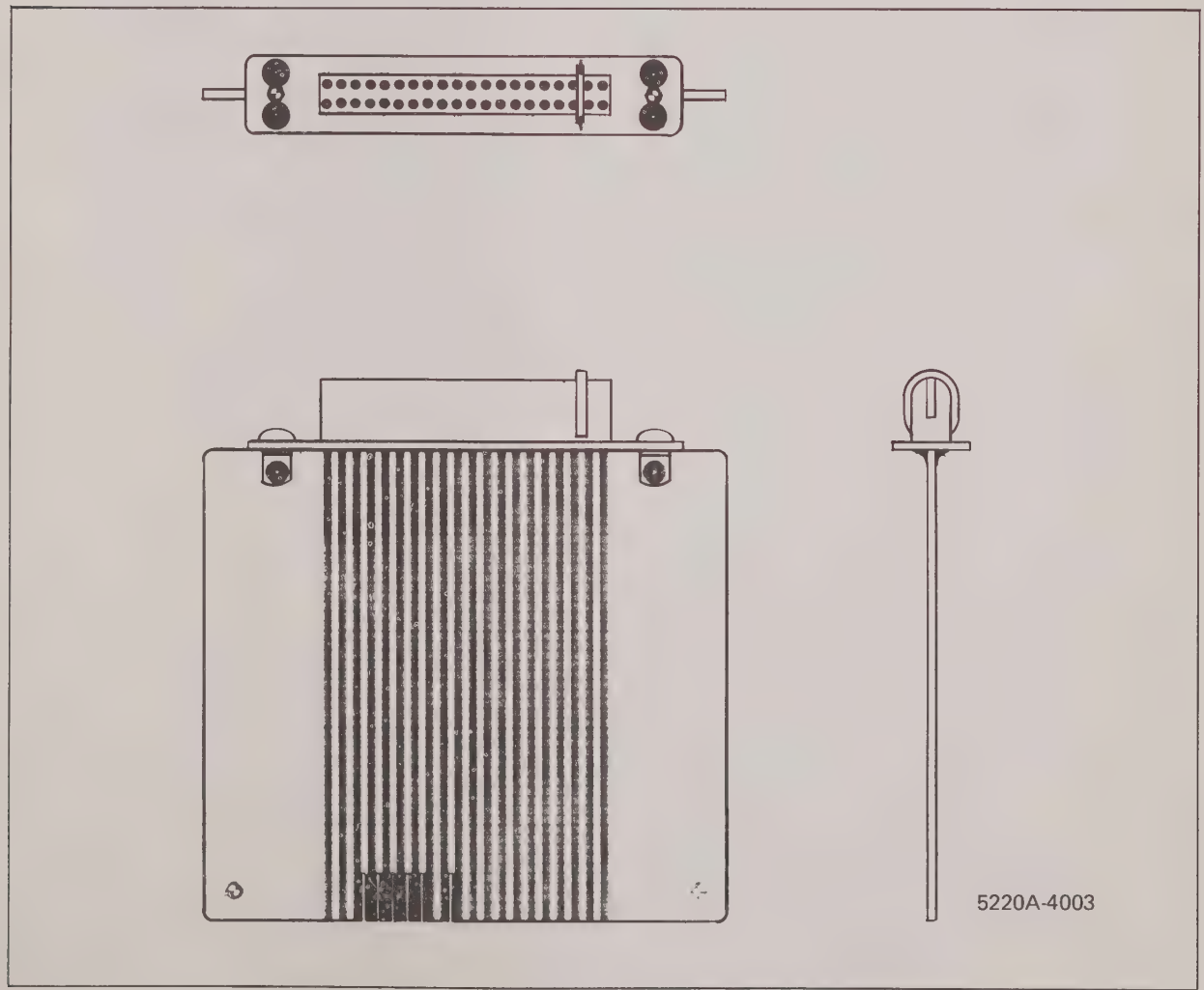


Figure 5-15. A14 Extender PCB Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	PAGE
	ACCESSORIES	
M00-205-600	Rack Mounting Kit	600-1
M00-280-610	Rack Slide Kit	600-1
Y5020	Current Shunt	600-1

6-1. INTRODUCTION

6-2. This section of the manual documents the options and accessories available for use with the 5220A. Currently, there are no options, and the accessories are limited to a choice of two rack-mounting kits and a precision current shunt for calibration purposes. Each is described in the following accessories subsection.

Accessories

600-1. RACK MOUNTING KIT (M00-205-600)

600-2. The 5220A can be rack mounted in a standard 19-inch equipment rack using Rack Mounting Kit M00-200-605. Use the following procedure to install the kit:

1. Peel off the name plate decals from the front side corners of the instrument.

2. Remove the front corner screws which match the hole pattern in the rack mounting ears (see Figure 600-1).

3. Attach the rack mounting ears to the front corners of the unit using the screws supplied in the rack mounting kit.

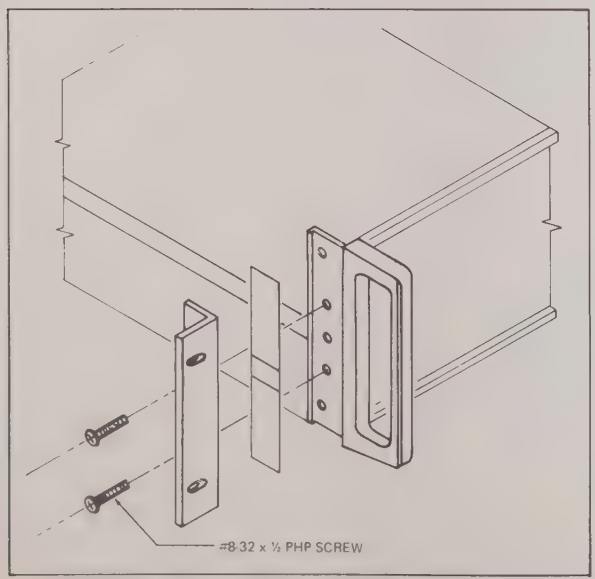


Figure 600-1. Rack Mounting Kit

600-3. RACK SLIDE KIT (M00-280-610)

600-4. The 5220A can be rack mounted in a 24-inch deep equipment rack using the Rack Slide Kit M00-280-610. Use the following procedure to install the kit:

1. Remove the horizontal side trim decal from both sides of the instrument.

2. Refer to Figure 600-2. Using the screws supplied with the kit, attach the chassis section (B) of the slide kit to each side of the unit. Use the center row of mounting holes.

3. Install the cabinet section (D) of the center section (C) in the equipment rack.

4. Pull the center section of the slide out through the front of the equipment rack until it locks in the extended position.

5. Depress the spring locks on the chassis section (B) and join sections B and C.

6. Push the instrument into the equipment rack and then pull it out to the extended position. The spring locks should limit the rack slide travel.

600-5. Y5020 CURRENT SHUNT

600-6. The Model Y5020 is a precision, high-current shunt recommended for use in calibrating the Model 5220A Transconductance Amplifier. An instruction manual is supplied with the unit.

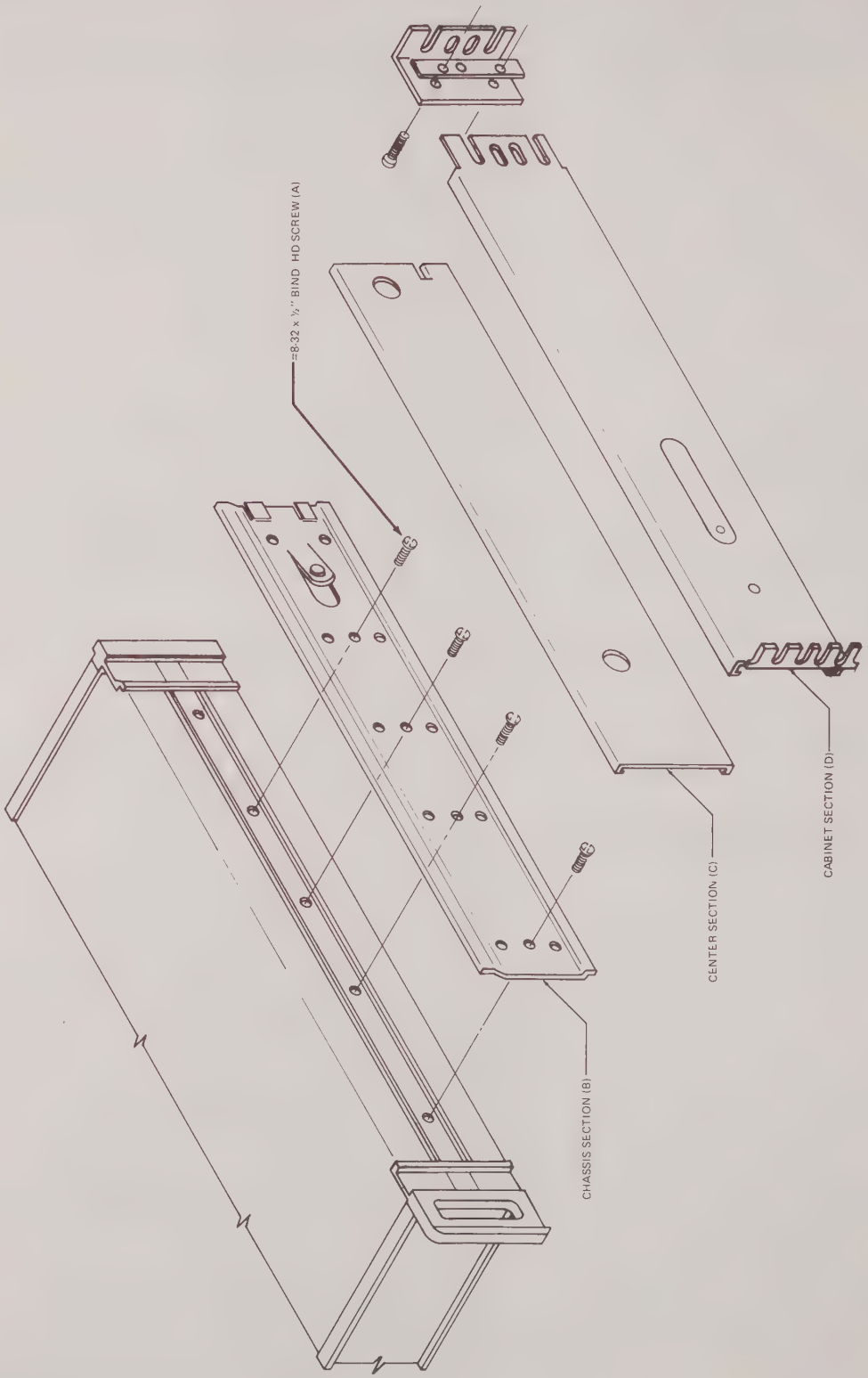


Figure 600-2. Rack Slide Kit

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5. The following information is presented in this section:

List of Abbreviations
Federal Supply Codes for Manufacturers
Fluke Technical Service Centers — U.S. and Canada
Sales and Service Locations — International
Sales Representatives — U.S. and Canada

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
^{o}C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
^{o}F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^{9})
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^{3})
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^{6})
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(—) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers (Continued)

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept.
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

Federal Supply Codes for Manufacturers (Continued)

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
G T E Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
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Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
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Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
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23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

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Chicago, Illinois

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Cinch Connector Operations Div.
Elk Grove Village, Chicago, Illinois

72005
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Newark, New Jersey

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Replaced by 06980

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Replaced by 90303

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South Boston, Massachusetts

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Rockville, Maryland

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Peabody, Massachusetts

86577
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of Malden Inc.
Stoneham, Massachusetts

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Electronic Components Div.
Harrison, New Jersey

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Trenton, New Jersey

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Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

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Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

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Suglex/IWP Div.
Newmarket, New Hampshire

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Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

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Santa Clara, California

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Augat Inc.
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91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

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Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

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Honeywell Inc.
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Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
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Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

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95348
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formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
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97540
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Div. of Whitehall Electronics Corp.
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97913
Industrial Electronic Hdware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
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Pasadena, California

98291
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Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
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Burbank, California

99392
STM
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99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
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99800
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*Hispano Electronica S.A.
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Appendix 7A
Manual Change Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

CHANGES

There are no backdating changes at this printing. All pcb assemblies are documented at their original revision level.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter																					
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P							
A1	Motherboard PCB Assembly	48691	●	X																				
A3	Cap Bus PCB Assembly (GP05)	476994	X																					
A4	Regulator PCB Assembly	487694	●	●	X																			
A5	Preamplifier PCB Assembly	486266	●	●	X																			
A6	Driver PCB Assembly	486241	●	●	●	X																		
A7	Output Assembly	486233	●	●	X																			
A8	Analog Control PCB Assembly	486258	●	X																				
A9	Front Panel PCB Assembly	486225	●	X																				
A10	Logic PCB Assembly	486274	●	●	X																			
A11	MIS Bus Interface PCB Assembly	486282	X																					
A13	Output Termination PCB Assembly	491274	●	X																				

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
— = No revision letter on the PCB.

Section 8
Schematic Diagrams

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J10	MNEMONICS	TO
1	NC	
2	NC	
3	NC	
4	NC	
5	STANDBY/OPERATE PB	J60-40
6	NC	
7	LOCAL PB	J60-39
8	NC	
9	NC	
10	REMOTE LED	J60-29
11 (23)	+5V	
12 (24)	COM 3	
13	THERMAL CUTOUT LED	J60-38
14	OVER COMPLIANCE LED	J60-37
15	OVER CURRENT LED	J60-36
16	NC	
17	LLO LED	J60-35
18	OPERATE LED	J60-34
19	STANDBY LED	J60-33
20	FRONT/REAR PB	J60-32
21	FRONT PANEL INPUT LED	J60-31
22	REAR PANEL INPUT LED	J60-30
23 (11)	+5V	
24 (12)	COM 3	

J30	MNEMONICS	TO
1 (21)	+12V	J20-1(21)
2 (22)	+EMITTER RES SENSE	J20-2(22)
3 (23)	NC	
4 (24)	+ DRIVE	J20-4(24)
5 (25)	NC	
6 (26)	Q107-COLLECTOR	J20-6(26)
7 (27)	Q107-BASE	J20-7(27)
8 (28)	Q107-EMITTER	J20-8(28)
9 (29)	THERMAL SW 1 (NC)	
10 (30)	THERMAL SW 2 (NC)	
11 (31)	SHUNT SENSE 2	J50-6(26)
12 (32)	SHUNT SENSE 1	J50-7(27)
13 (33)	TURN ON 2	J40-15(35)
14 (34)	TURN ON 1	J40-16(36)
15 (35)	OUT +	
16 (36)	DRIVE IN	
17 (37)	- DRIVE	J20-17(37)
18 (38)	COM 2	
19 (39)	- EMITTER RES SENSE	J20-19(39)
20 (40)	-12V	J20-20(40)
21 (1)	+12V	J20-1(21)
22 (2)	+EMITTER RES SENSE	J20-2(22)
23 (3)	NC	
24 (4)	+ DRIVE	J20-4(24)
25 (5)	NC	
26 (6)	Q107-COLLECTOR	J20-6(26)
27 (7)	Q107-BASE	J20-7(27)
28 (8)	Q107-EMITTER	J20-8(28)
29 (9)	THERMAL SW 1 (NC)	
30 (10)	THERMAL SW 2 (NC)	
31 (11)	SHUNT SENSE 2	J50-6(26)
32 (12)	SHUNT SENSE 1	J50-7(27)
33 (13)	TURN ON 2	J40-15(35)
34 (14)	TURN ON 1	J40-16(36)
35 (15)	OUT +	
36 (16)	DRIVE IN	
37 (17)	- DRIVE	J20-17(37)
38 (18)	COM 2	
39 (19)	- EMITTER RES SENSE	J20-19(39)
40 (20)	-12V	J20-20(40)

J20	MNEMONICS	TO
1 (21)	+12V	J30-1(21)
2 (22)	+EMITTER RES. SENSE	J30-2(22)
3 (23)	NC	
4 (24)	+ DRIVE	J30-4(24)
5 (25)	NC	
6 (26)	Q107-COLLECTOR	J30-6(26)
7 (27)	Q107-BASE	J30-7(27)
8 (28)	Q107-EMITTER	J30-8(28)
9 (29)	THERMAL SW 1	J60-25
10 (30)	THERMAL SW 2	J60-8
11 (31)	NC	
12 (32)	NC	
13 (33)	NC	
14 (34)	NC	
15 (35)	OUT +	
16 (36)	NC	
17 (37)	- DRIVE	J30-17(37)
18 (38)	COM 2	
19 (39)	-EMITTER RES. SENSE	J30-19(39)
20 (40)	-12V	J30-20(40)
21 (1)	+12V	J30-1(21)
22 (2)	+EMITTER RES. SENSE	J30-2(22)
23 (3)	NC	
24 (4)	+ DRIVE	J30-4(24)
25 (5)	NC	
26 (6)	Q107-COLLECTOR	J30-6(26)
27 (7)	Q107-BASE	J30-7(27)
28 (8)	Q107-EMITTER	J30-8(28)
29 (9)	THERMAL SW 1	J60-25
30 (10)	THERMAL SW 2	J60-8
31 (11)	NC	
32 (12)	NC	
33 (13)	NC	
34 (14)	NC	
35 (15)	OUT +	
36 (16)	NC	
37 (17)	-DRIVE	J30-17(37)
38 (18)	COM 2	
39 (19)	-EMITTER RES SENSE	J30-19(39)
40 (20)	-12V	J30-20(40)

J40	MNEMONICS	TO
1	T4	J60-24
2	NC	
3 (23)	COM 3	
4 (24)	+5V	
5 (25)	NC	
6 (26)	NC	
7 (27)	SHUNT SENSE 2 (NC)	
8 (28)	SHUNT SENSE 1 (NC)	
9	NC	
10	NC	
11	COM 1 (NOT USED)	
12 (32)	-15V	
13 (33)	NC	
14 (34)	+15V	
15 (35)	TURN ON 2 (NC)	J30-13(33)
16 (36)	TURN ON 1	J30-14(34)
17 (37)	FET DRIVE 1	J50-37
18 (38)	OUT +	
19 (39)	DRIVE IN(NC)	
20 (40)	COM 2	
21	OVER COMPLIANCE	J60-23
22	OVER CURRENT	J60-22
23 (3)	COM 3	
24 (4)	+5V	
25 (5)	NC	
26 (6)	NC	
27 (7)	SHUNT SENSE 2 (NC)	
28 (8)	SHUNT SENSE 1 (NC)	
29	T2	P60-11
30	T1	P60-10
31	COM 1 (NOT USED)	
32 (12)	-15V	
33 (13)	NC	
34 (14)	+15V	
35 (15)	TURN ON (2 NC)	J30-13(33)
36 (16)	TURN ON 1	J30-14(34)
37 (17)	FET DRIVE 1	J50-37
38 (18)	OUT +	
39 (19)	DRIVE IN (NC)	
40 (20)	COM 2	

5220A-1001 (Sheet 1 of 2)

Figure 8-1. 5220A Interconnect Information

PERFORMANCE TEST

MFG _____ **DATE**_____
ID NO._____ **CODE**_____
SERIAL NO._____ **TECH**_____
MODEL _____ **ITEM IDENT**_____

PROCEEDURE FOUND IN MAINTAINACE MANUAL FOR FLUKE 5220A (PGS. 4-46 TO 4-8)

step 1. WARM UP FOR 30 MINUTES

sec.4-45. front panel tests

stand by light	_____
operate light	_____
front input light	_____
rear input light	_____
overcompliance light	_____

sec. 4-47 ZERO OUTPUT

step 3	less than 5 uV?	_____
step 6	less than 100 uV?	_____

sec. 4-49 DC ACCURACY AND LINE REGULATION

STEP	DC CALIBRATOR OUTPUT	CALCULATED OUT	ACTUAL
1	+10.0000	9.9965 TO 10.0035	_____
2	+20.0000	19.9940 TO 20.0060	_____
3	-10.0000	10.0035 TO 9.9965	_____

sec.4-51 HARMONIC DISTORTION

step 6. MEASURE OUTPUT DISTORTION <0.05% _____

sec.4-53 FREQUENCY RESPONSE

STEP	AC VOLTAGE CALIBRATOR	CALCULATED OUT	ACTUAL
1	20V at 100Hz	19.970 to 20.030	_____
2	20V at 300Hz	reading 1 ± .05%	_____
3	20V at 1 kHz	reading 1 ± .05%	_____
4	20V at 3 KHz	reading 1 ± .15%	_____
4	20V at 5 KHz	reading 1 ± .25%	_____

sec.4-55 OVERCURRENT TRIP TEST

TRIP POINT? _____

sec.4-57 OVERVOLTAGE TRIP TEST

OPERATES? _____

REJECTED ____

TEST TYPE: TRANSCONDTANCE AMP

ITEM IDENT: A59600

SERIAL NO. 2320032

OTHER: FLUKE 5220A

DATE: 28 MAR 80 PAGE 1 OF 2

PROJECT: RESULTS:

TECH: AL IN SPECS ____

ID NO.: OUT OF SPECS ____

1. FT PANEL CHECKS

OPR LED —OK

STDBY LED —OK

FT & REAR LED'S —OK

OVERCOMP LED —OK

2 ZERO OUTPUT

5220 IN STNDBY — 0MV

5220 IN OPER — 6MV

3 DC ACCUR

STEP	DC CALIB OUT	CALC CURRENT	TOL
1	+10.0000V	9.999799A	9.9965 - 10.0035
2	+20.0000V	19.99829A	↓
3	-10.0000V	-10.000501A	↓

4 LINE REGULAT

Ø CHANGE FROM 115VA TO 105 & 125VAC

5 HARMONIC DIST

5200A DIST .02% (20V)

5220A DIST .06% W/2V (2A)

USING .62 N85-797

STD REST

REJECTED ____

TEST TYPE: _____

ITEM IDENT: _____

SERIAL NO. _____

OTHER: _____

DATE: _____ PAGE 2 OF 2

PROJECT: _____ RESULTS:

TECH: _____ IN SPECS ____

ID NO.: _____ OUT OF SPECS ____

6. FREQ RESP

STEP	AC VOLT CALIB	MEAS. OUTPUT	TOL.
1	20V @ 100HZ	20.0002A	19.970 – 20.030
2	20V @ 300HZ	20.0042A	±.0100 (±.05%)
3	20V @ 1 KHZ	20.0062A	±.0100 ↓
4	20V @ 3 KHZ	20.0192A	±.0300 (±.15%)
5	20V @ 5KHZ	20.0343A	±.0500 (±.05%)

7 OVERCURRENT TRIP TEST (.1Ω)
TRIP @ 24V 20V TO 24V

8 OVERVOLT TRIP TEST (1Ω)
TRIP @ 3.2V 3.1V TO 3.5V

FLUKE®

Instruction Sheet

Model Y5002

Interface Cable Assembly

The Y5002 is a custom-built cable that provides an interface between the Y5000 5100 Series Interface and a Fluke Model 5220A Transconductance Amplifier.

NOTE

Since the described cable assembly is custom-built to operate with the Y5000 5100 Series Interface, it is suggested that this instruction sheet be permanently filed with the Y5000 Instruction Manual.

The end of the cable assembly that connects to the Y5000 has two connectors. One is a 36-pin male connector that connects to the digital output (J1 or subsequent odd numbers), the other a 14-pin male connector that goes to the analog output (J2 or subsequent even numbers). The other end of the cable has a 24-pin male connector that goes to the jack labeled P71 on the Model 5220A rear panel. The pin-to-pin connections in the cable are shown in Figure 1.

The connectors used in the cable assembly are standard items. The 36-pin connector is Fluke Part Number 158451, Manufacturer's Federal Supply Code 71785, and Manufacturer's Part Number 57-30360. The other two connectors, in the same sequence are:

Connector, Male, 14-pin; 272443; 71785; 57-30140
Connector, Male, 24-pin; 272427; 71785; 57-30240.
The quantity for all items is one.

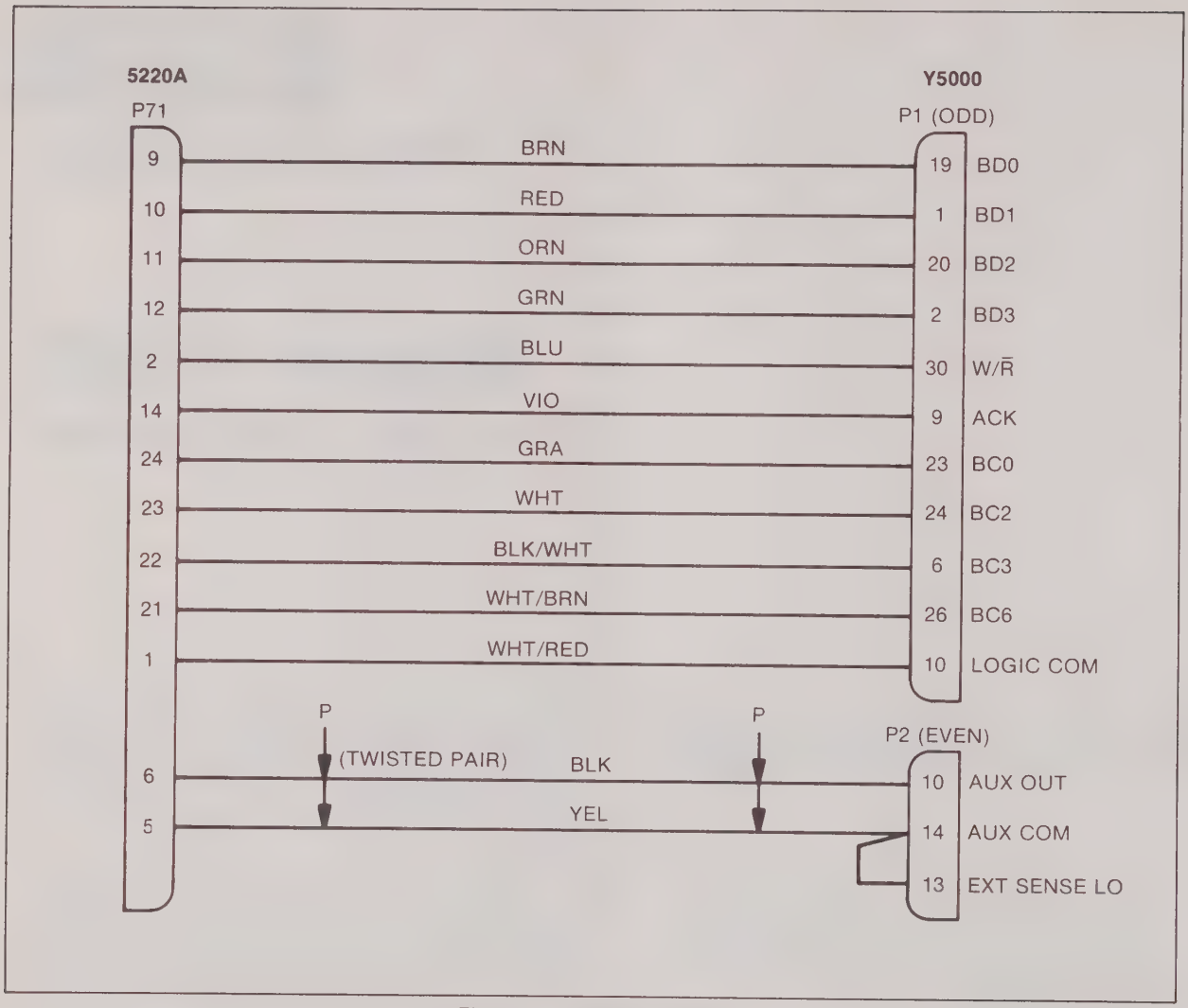

Figure 1. Y5002 Schematic

J50	MNEMONICS	TO
1	COM 3	
2	RELAY 1	J60-19
3	REAR INPUT LO	J70-20
4	FRONT INPUT LO	
5	NC	
6(26)	SHUNT SENSE 2	J30-11(31)
7(27)	SHUNT SENSE 1	J30-12(32)
8	NC	
9	NC	
10	NC	
11	NC	
12(32)	-15V	
13(33)	COM 1	
14(34)	+15V	
15(35)	NC	
16	NC	
17	NC	
18	NC	
19(39)	DRIVE IN	
20	NC	
21	+5V	
22	RELAY 2	J60-20
23	REAR INPUT HI	J70-40
24	FRONT INPUT HI	
25	NC	
26(6)	SHUNT SENSE 2	J30-11(31)
27(7)	SHUNT SENSE 1	J30-12(32)
28	NC	
29	NC	
30	NC	
31	NC	
32(12)	-15V	
33(13)	COM 1	
34(14)	+15V	
35(15)	NC	
36	NC	
37	FET DRIVE 1	J40-17(37)
38	NC	
39(19)	DRIVE IN	
40	NC	

J60	MNEMONICS	TO
1(21)	+5 ISO	
2	REMOTE	J70-4(24)
3	LLO	J70-6(26)
4	OPERATE	J70-5(25)
5	REAR	J70-7(27)
6(26)	COM 3	
7(27)	+5V	
8	THERMAL SW 2	J20-10(30)
9	NC	
10	T1	J40-30
11	T2	J40-29
12	NC	
13	NC	
14	LINE MON	J90-14(34)
15	NC	
16	INTERFACE REMOTE STATUS	J70-14(34)
17	INTERFACE OPERATE STATUS	J70-15(35)
18	INTERFACE OVERLOAD STATUS	J70-16(36)
19	RELAY 1	J50-2
20	RELAY 2	J50-22
21(1)	+5 ISO	
22	OVER CURRENT	J40-22
23	OVER COMPLIANCE	J40-21
24	T4	J40-1
25	THERMAL SW 1	J20-9(29)
26(6)	COM 3	
27(7)	+5 V	
28	NC	
29	REMOTE LED	J10-10
30	REAR PANEL INPUT LED	J10-22
31	FRONT PANEL INPUT LED	J10-21
32	REAR/FRONT PB	J10-20
33	STAND BY LED	J10-19
34	OPERATE LED	J10-18
35	LLO LED	J10-17
36	OVER CURRENT LED	J10-15
37	OVER COMPLIACE LED	J10-14
38	THERMAL CUTOUT LED	J10-13
39	LOCAL PB	J10-7
40	STANDBY/OPERATE PB	J10-5

J70	MNEMONICS	TO
1(21)	+5 ISO	
2(22)	COM 4	
3	NC	
4(24)	REMOTE	J60-2
5(25)	OPERATE	J60-4
6(26)	LLO	J60-3
7(27)	REAR	J60-5
8	NC	
9	NC	
10	NC	
11	NC	
12	NC	
13	NC	
14(34)	INTERFACE REMOTE STATUS	J60-16
15(35)	INTERFACE OPERATE STATUS	J60-17
16(36)	INTERFACE OVERLOAD STATUS	J60-18
17	NC	
18	NC	
19	NC	
20	REAR INPUT LO	J50-3
21(1)	+5 ISO	
22(2)	COM 4	
23	NC	
24(4)	REMOTE	J60-2
25(5)	OPERATE	J60-4
26(6)	LLO	J60-3
27(7)	REAR	J60-5
28	NC	
29	NC	
30	NC	
31	NC	
32	NC	
33	NC	
34(14)	INTERFACE REMOTE STATUS	J60-16
35(15)	INTERFACE OPERATE STATUS	J60-17
36(16)	INTERFACE OVERLOAD STATUS	J60-18
37	NC	
38	NC	
39	NC	
40	REAR INPUT HI	J50-23

J71	MNEMONICS	TO
1	COM 4	
2	W/R	
3	NC	
4	AUX COM	
5	AUX COM	
6	AUX OUT	
7	NC	
8	NC	
9	BDØ	
10	BD1	
11	BD2	
12	BD3	
13	NC	
14	ACK	
15	NC	
16	NC	
17	NC	
18	NC	
19	NC	
20	NC	
21	BC6	
22	BC3	
23	BC2	
24	BCØ	

J80	MNEMONICS	TO
1	NC	
2	NC	
3	NC	
4	NC	
5	NC	
6	NC	
7(21)	CHASSIS	J1-2
8	NO PIN	
9(23)	LO LINE	PWR SW
10	NO PIN	
11(25)	HI LINE	PWR SW
12	NO PIN	
13	NC	
14	FAN	J1-4
15	NC	
16	NC	
17	NC	
18	NC	
19	NC	
20	NC	
21(7)	CHASSIS	J1-2
22	NO PIN	
23(9)	LO LINE	PWR SW
24	NO PIN	
25(11)	HI LINE	PWR SW
26	NO PIN	
27	FAN	J1-6
28	NC	

J90	MNEMONICS	TO
1(21)	6S	J85-1(13)
2(22)	6F	J85-2(14)
3(23)	NC	
4(24)	NC	
5(25)	COM 4	
6(26)	+5 ISO	
7(27)	NC	
8(28)	NC	
9(29)	3S	J85-6(18)
10(30)	3F	J85-8(20)
11(31)	+15V	
12(32)	COM 1	
13(33)	-15V	
14(34)	LINE MON	J60-14
15(35)	COM 3	
16(36)	+5V	
17(37)	NC	
18(38)	NC	
19(39)	5S	J85-11(23)
20(40	5F	J85-12(24)
21(1)	6S	J85-1(13)
22(2)	5F	J85-2(14)
23(3)	NC	
24(4)	NC	
25(5)	COM 4	
26(6)	+5 ISO	
27(7)	NC	
28(8)	NC	
29(9)	3S	J85-6(18)
30(10)	3F	J85-8(20)
31(11)	+15V	
32(12)	COM 1	
33(13)	-15V	
34(14)	LINE MON	J60-14
35(15)	COM 3	
36(16)	+5V	
37(17)	NC	
38(18)	NC	
39(19)	5S	J85-11(23)
40(20)	5F	J85-12(24)

J85	MNEMONICS	TO
1(13)	6S	J90-1(21)
2(14)	6F	J90-2(22)
3(15)	CHASSIS	
4(16)	NC	
5(17)	NC	
6(18)	3S	J90-9(29)
7(19)	COM 1	J90-12(32)
8(20)	3F	J90-10(30)
9(21)	NC	
10(22)	NC	
11(23)	5S	J90-19(39)
12(24)	5F	J90-20(40)

J1	MNEMONICS	TO
1	NC	
2	CHASSIS (SH)	
3	NO PIN	
4	FAN (RED)	J80-14
5	NO PIN	
6	FAN (GRN)	J80-27
7	NO PIN	
8	HI LINE (BLK)	PWR SW
9	NO PIN	
10	LO LINE (WHT)	PWR SW

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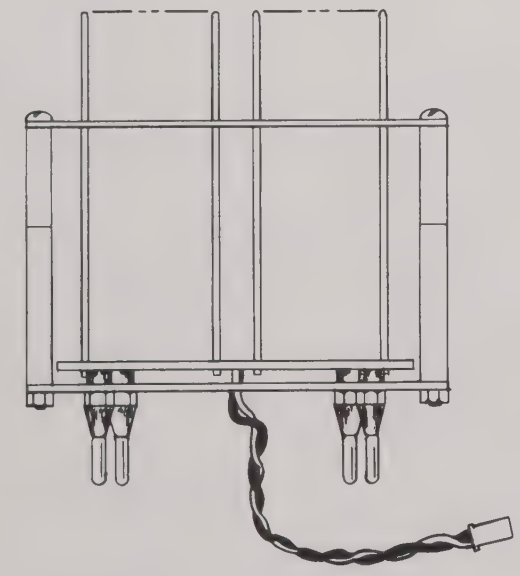
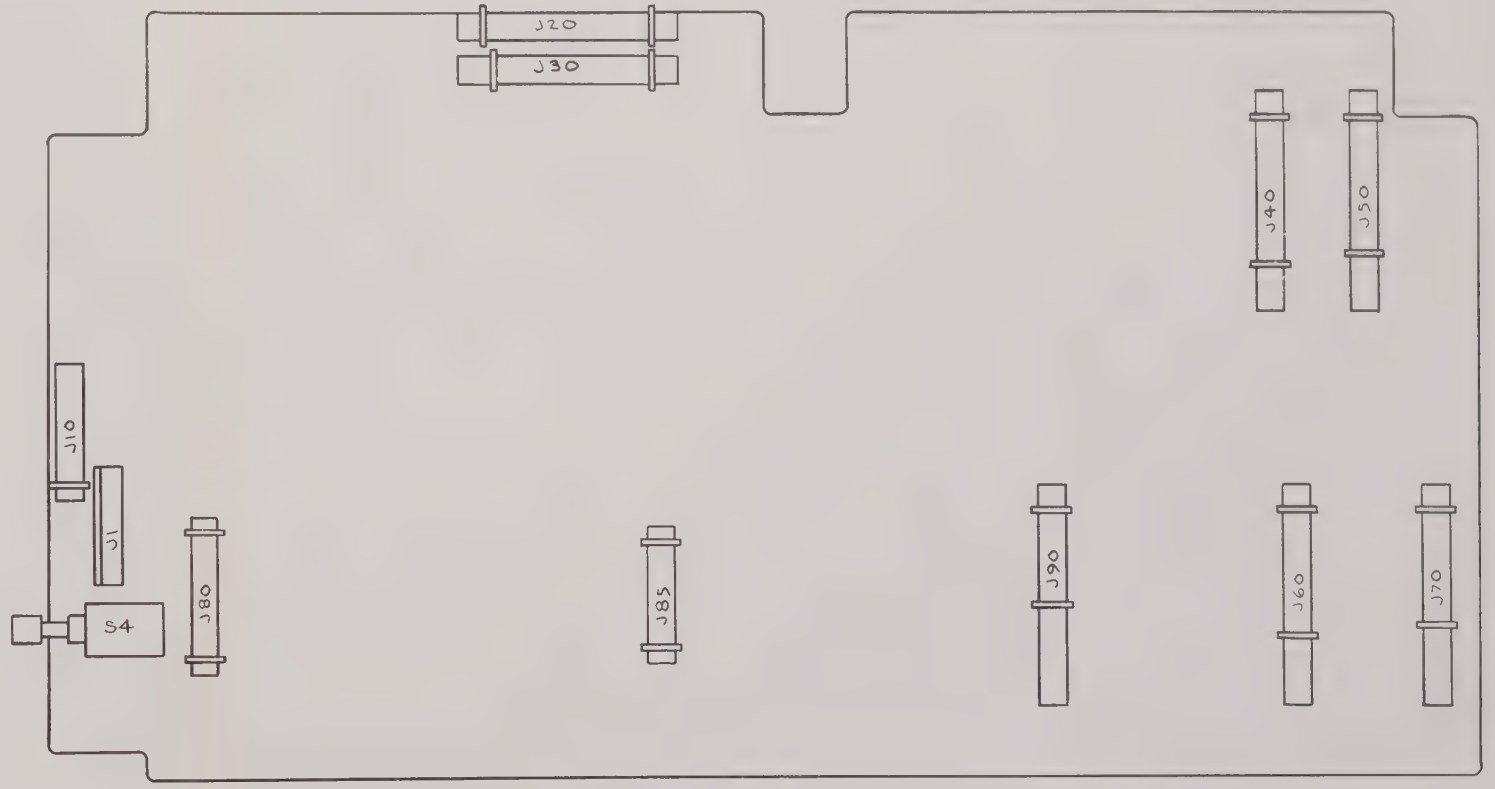
(Sheet 2 of 2)

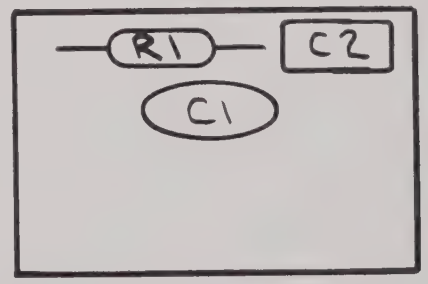
Figure 8-1. 5220A Interconnect Information (cont)



A12 Shunt Assembly (5220A-4202)

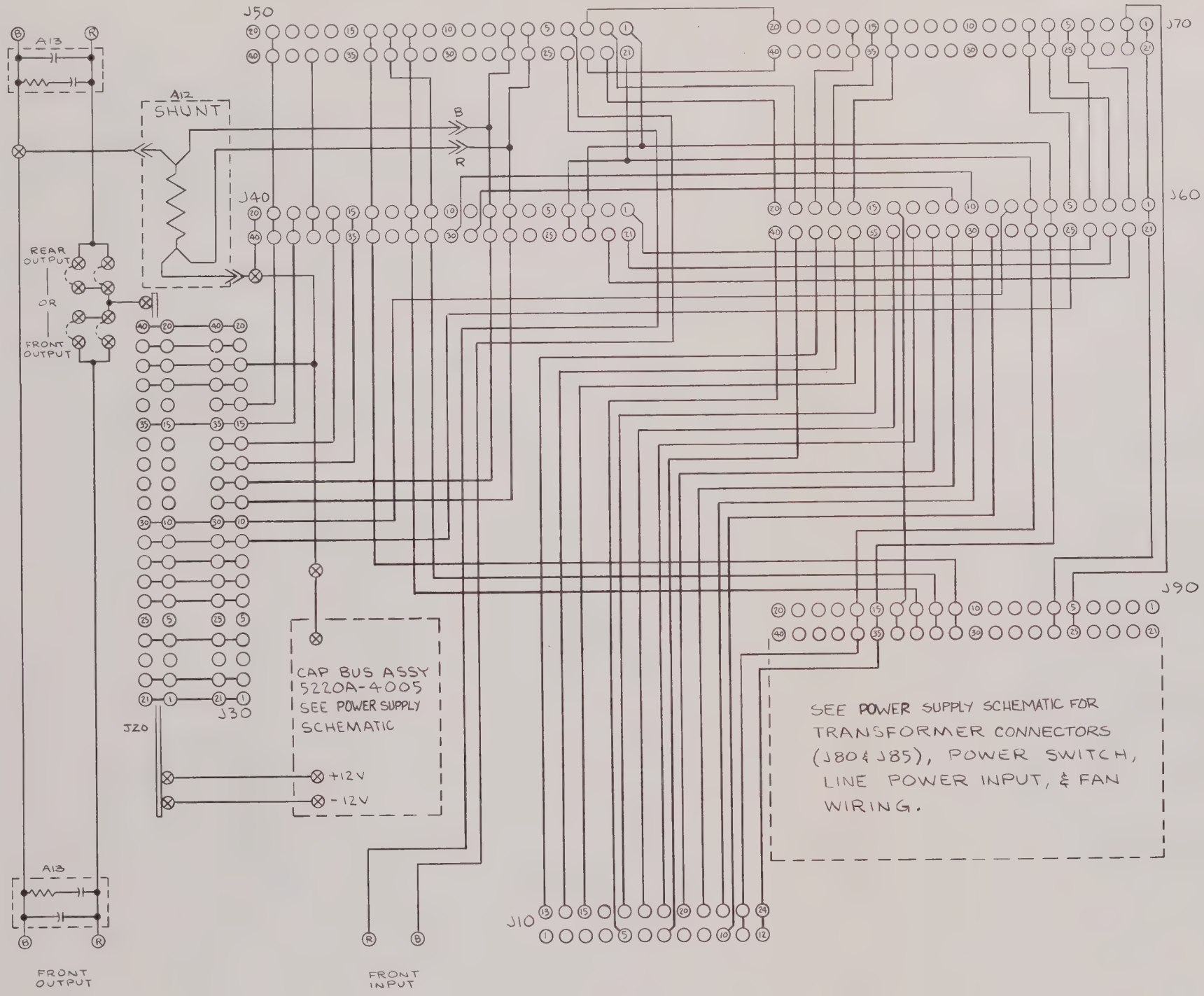


A1 Motherboard PCB Assembly (5220A-1601)



A13 Output Terminal PCB Wiring (5220A-1604)

Figure 8-2. A1 Motherboard, A12 Shunt and Chassis Wiring



CONNECTOR	PLUG-IN ASSEMBLY
J10	A9 Front Panel PCB
J20	A7 Output PCB
J30	A6 Driver PCB
J40	A8 Analog Control PCB
J50	A5 Preamplifier PCB
J60	A10 Logic PCB
J70	A11 MIS Bus I/F
J80	A2 Transformer Assembly
J85	A2 Transformer Assembly
J90	A4 Regulator PCB

NOTES:
1. ⊗ INDICATES A SCREW TERMINATION

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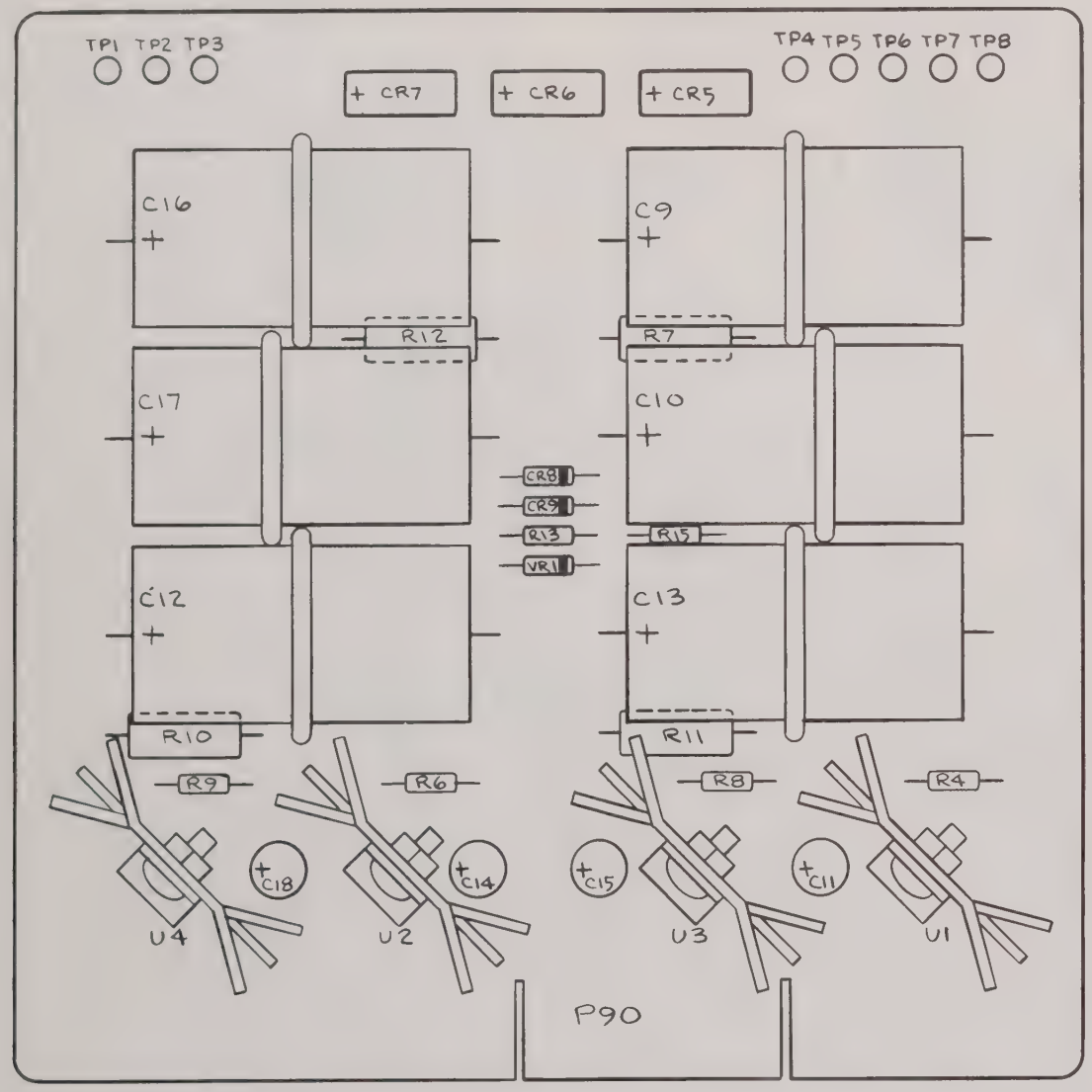
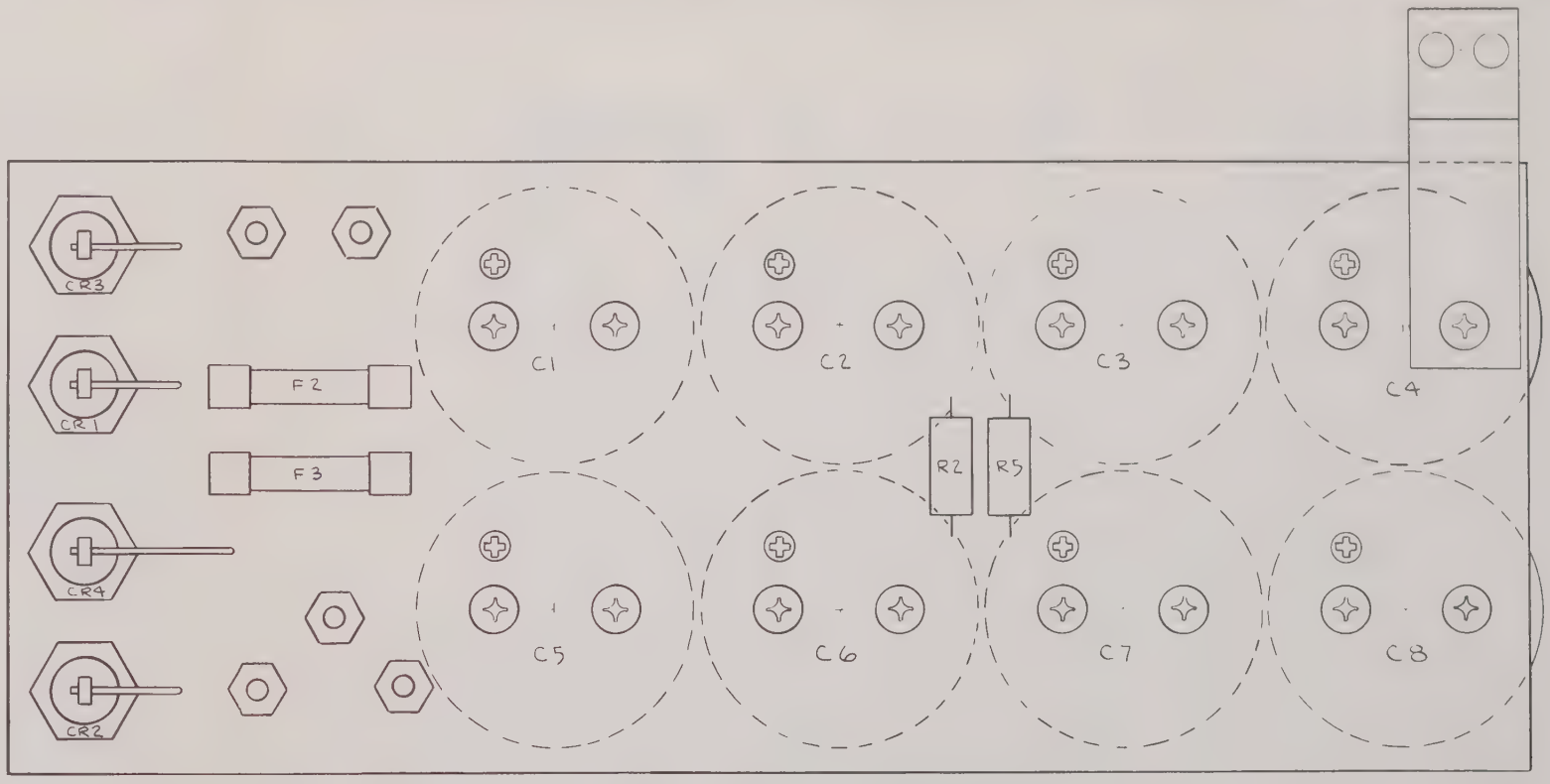
(Sheet 2 of 2)

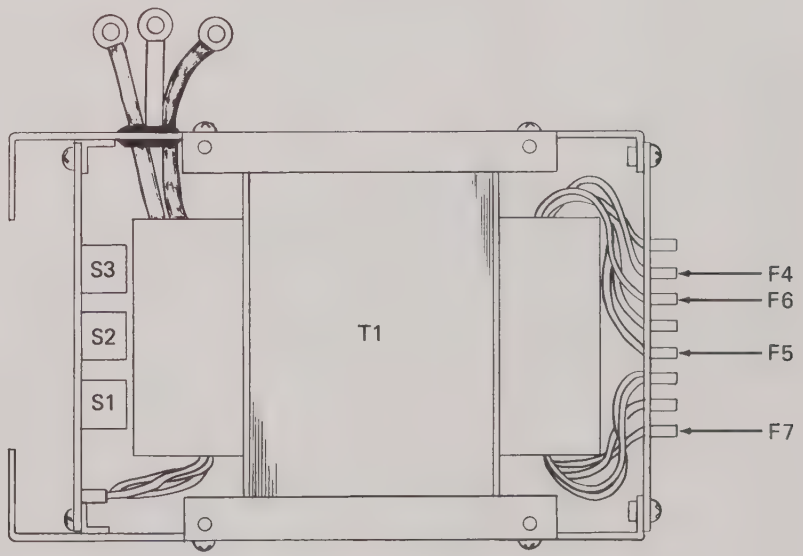
Figure 8-2. A1 Motherboard, A12 Shunt and Chassis Wiring (cont)



A4 Regulator PCB Assembly (5220A-1690)



A3 Cap Bus PCB Assembly (5220A-1605)

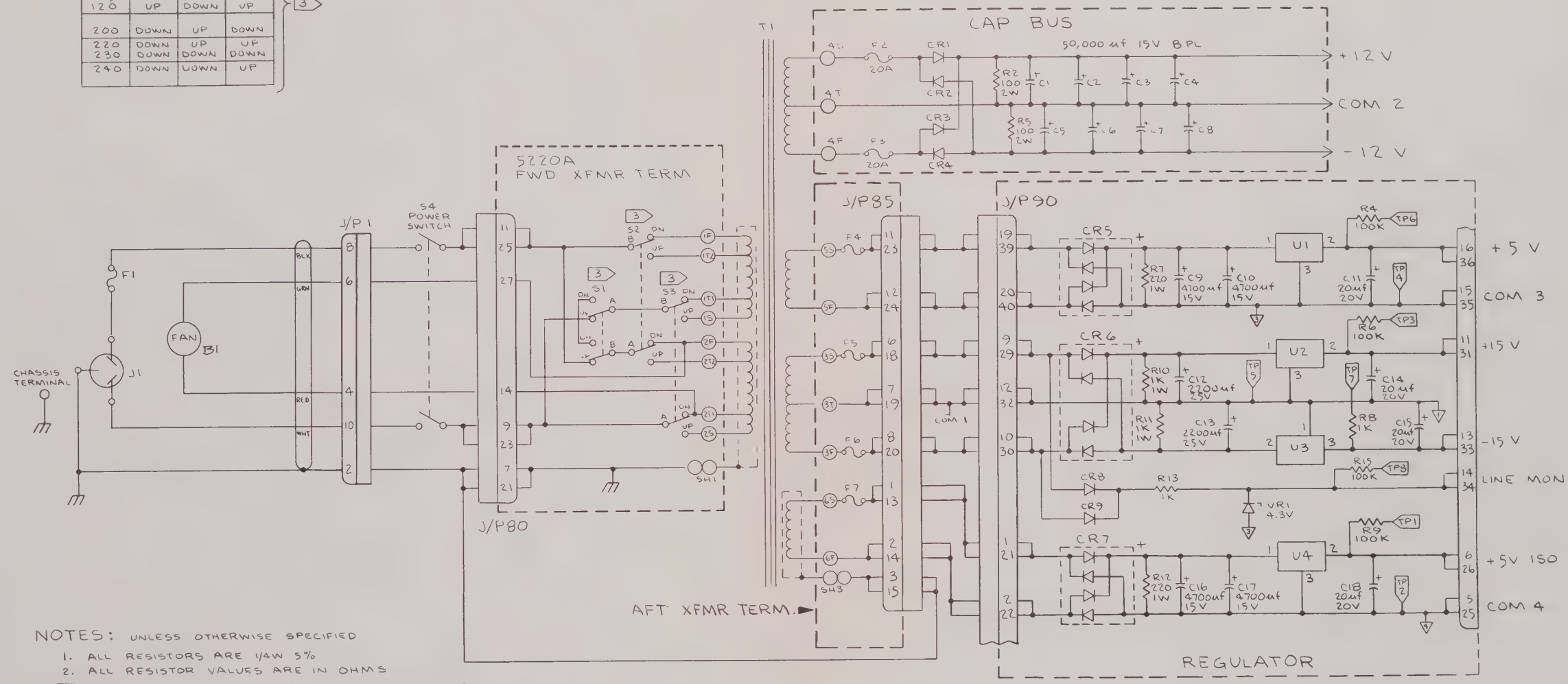


A2 Transformer Assembly (5220A-4201)

Figure 8-3. Power Supply

MAINS VOLTAGE TABLE			
VOLTAGE ±10%	POSITION OF DOTS		
	S1	S2	S3
100 110	UP UP	UP UP	DOWN UP
115 120	UP UP	DOWN DOWN	DOWN UP
200	DOWN	UP	DOWN
220 230	DOWN DOWN	UP DOWN	UP DOWN
240	DOWN	DOWN	UP

3



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 1/4W 5%
2. ALL RESISTOR VALUES ARE IN OHMS

3 POSITION OF DOTS ON SWITCHES IS ON SIDE OPPOSITE SWITCH CONTACTS

5220A-1090

Figure 8-3. Power Supply (cont)

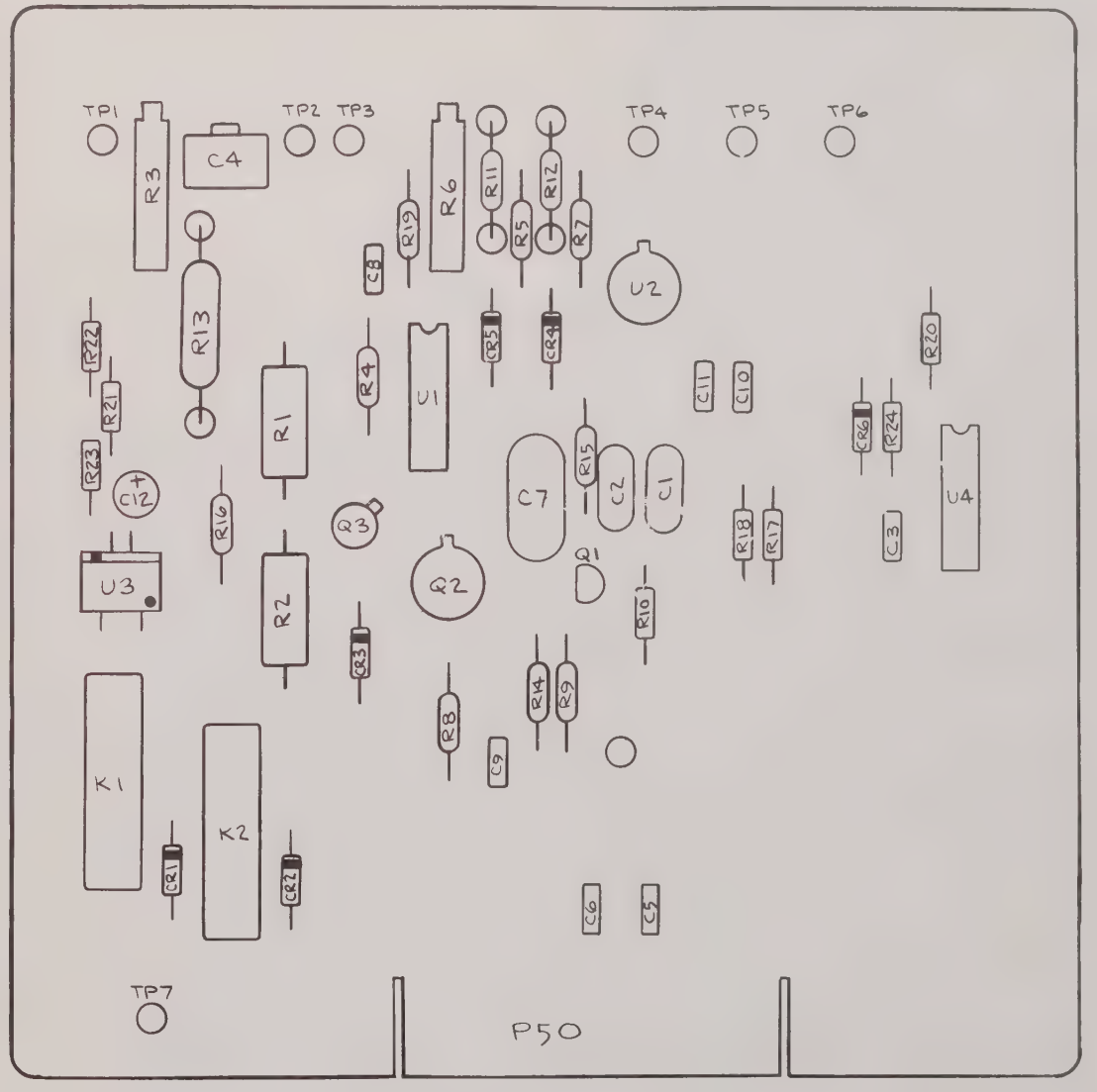


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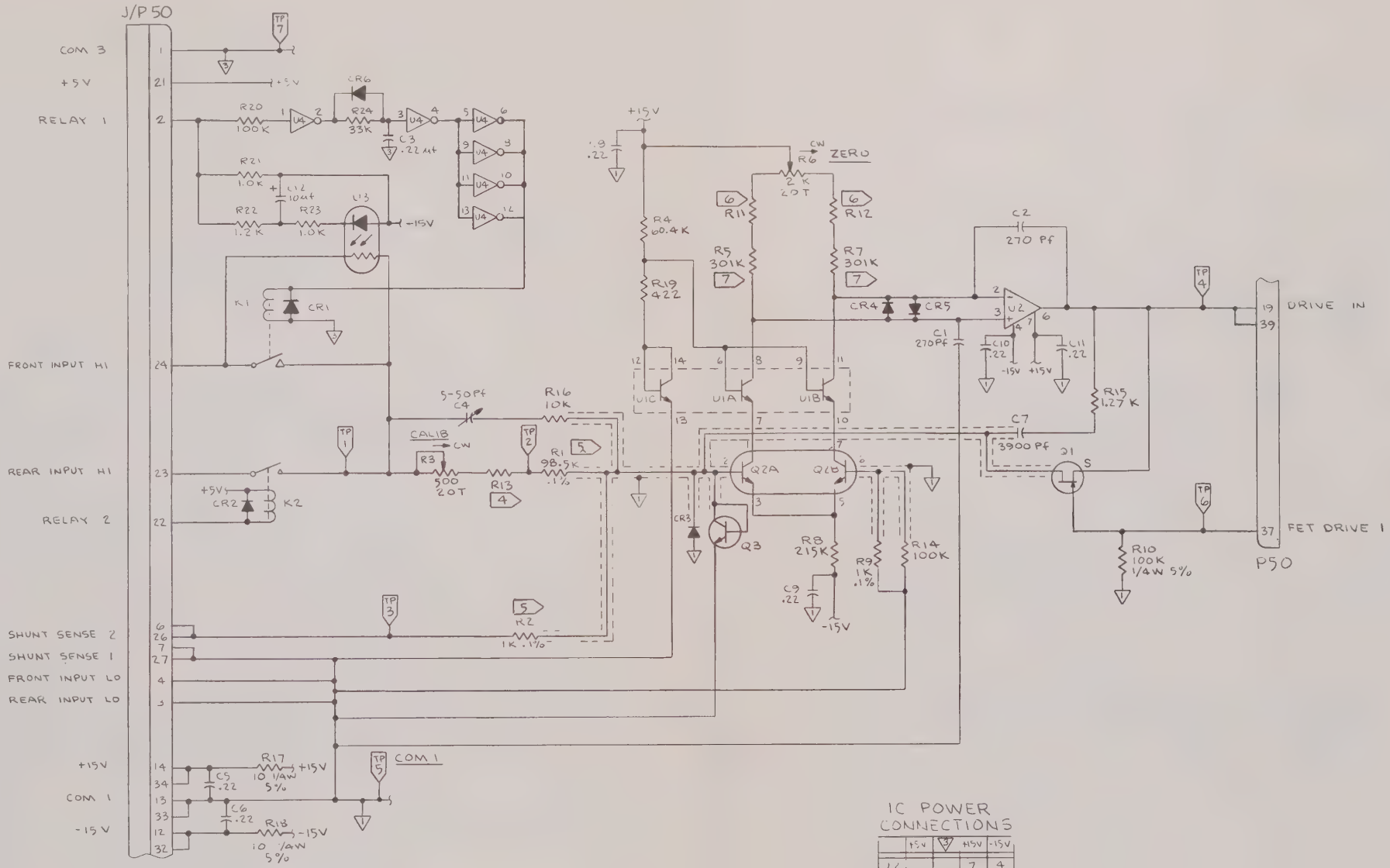
Figure 8-4. A5 Preamplifier PCB Assembly



IC POWER CONNECTIONS

	+5V	TP	+15V	-15V
IC			7	4
UA	14	7		

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS 1/8W MF 1% TO
2. ALL RESISTOR VALUES IN OHMS
3. ALL CAPACITOR VALUES IN MICROFARADS

4 SELECTED 1/2W MF RESISTOR OR SHORTING WIRE

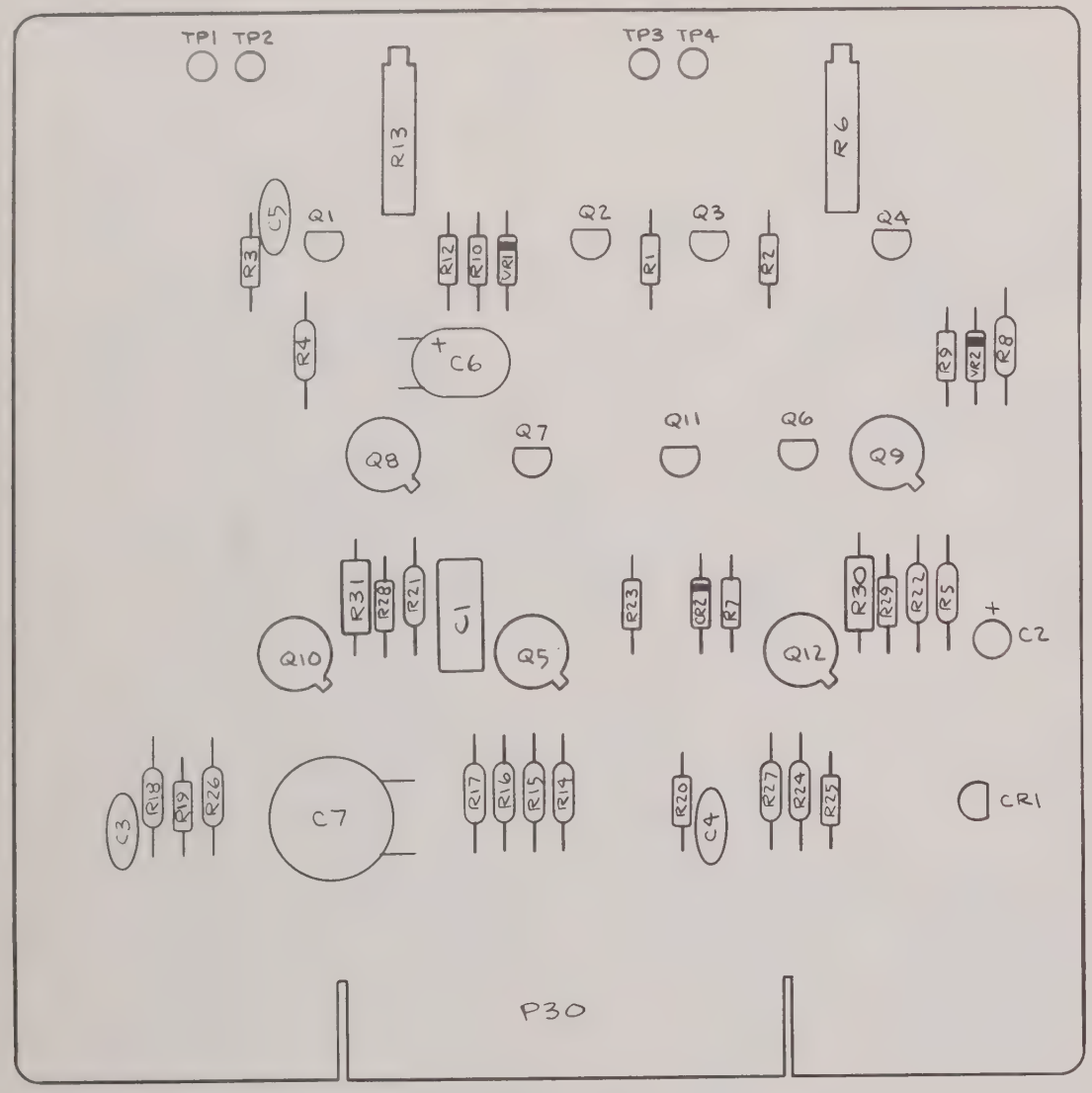
5 R1 & R2 ARE A MATCHED SET FOR TC J/F NO

6 R11 & R12 ARE EITHER 2 SHORTING WIRES OR 1 SHORTING WIRE & 1 RESISTOR (DETERMINED IN TEST)

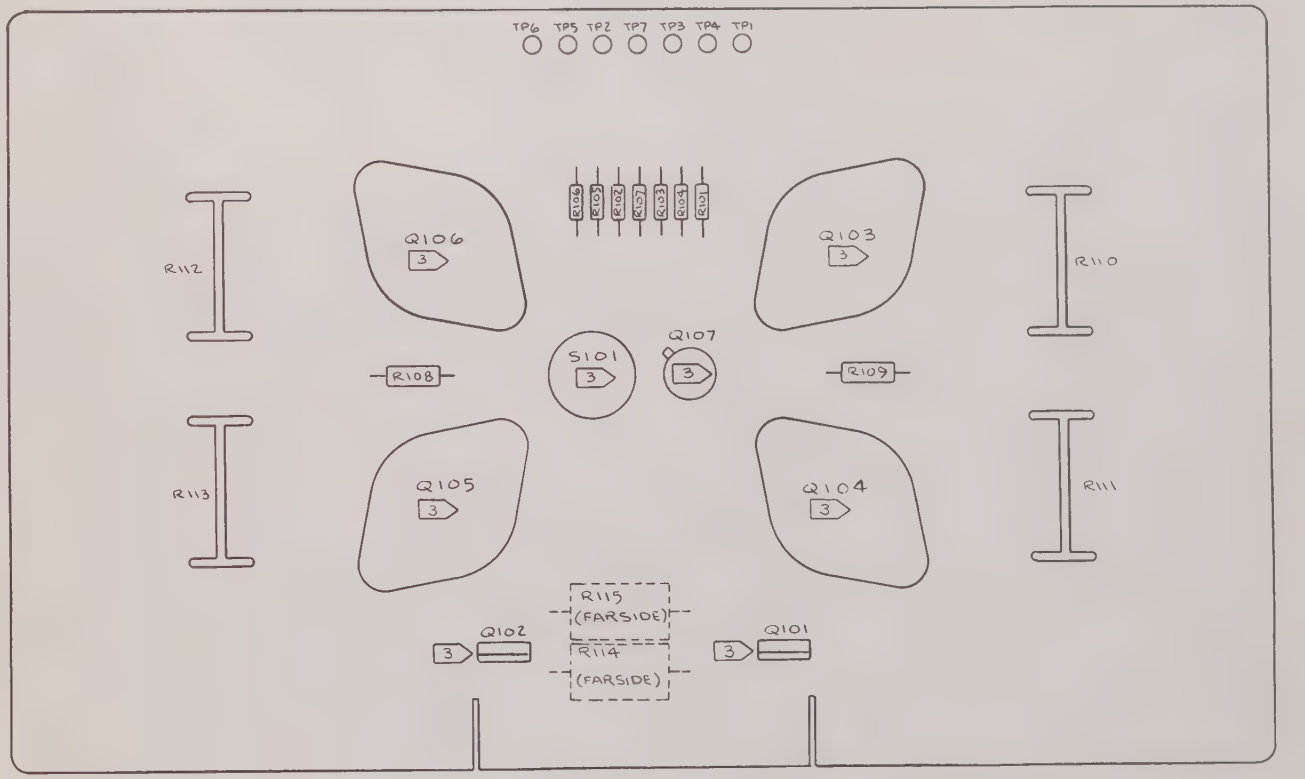
7 R5 & R7 ARE A MATCHED SET FOR TC J/F NO 502619

5220A-1050

Figure 8-4. A5 Preamplifier PCB Assembly (cont)



A6 Driver PCB Assembly (5220A-1630)



A7 Output PCB Assembly (5220A-1620)

Figure 8-5. A6 Driver and A7 Output PCB Assemblies

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE 1/4W, DC, 5%
2. RESISTOR VALUES ARE IN OHMS
3. CAPACITOR VALUES ARE IN MICROFARADS

5 J20 PINS 9,29 & 10,30 CONNECT TO J60 PINS 25 & 8
6 CONNECTS TO COMMON 2
7 CONNECTS TO J40-18 & 38

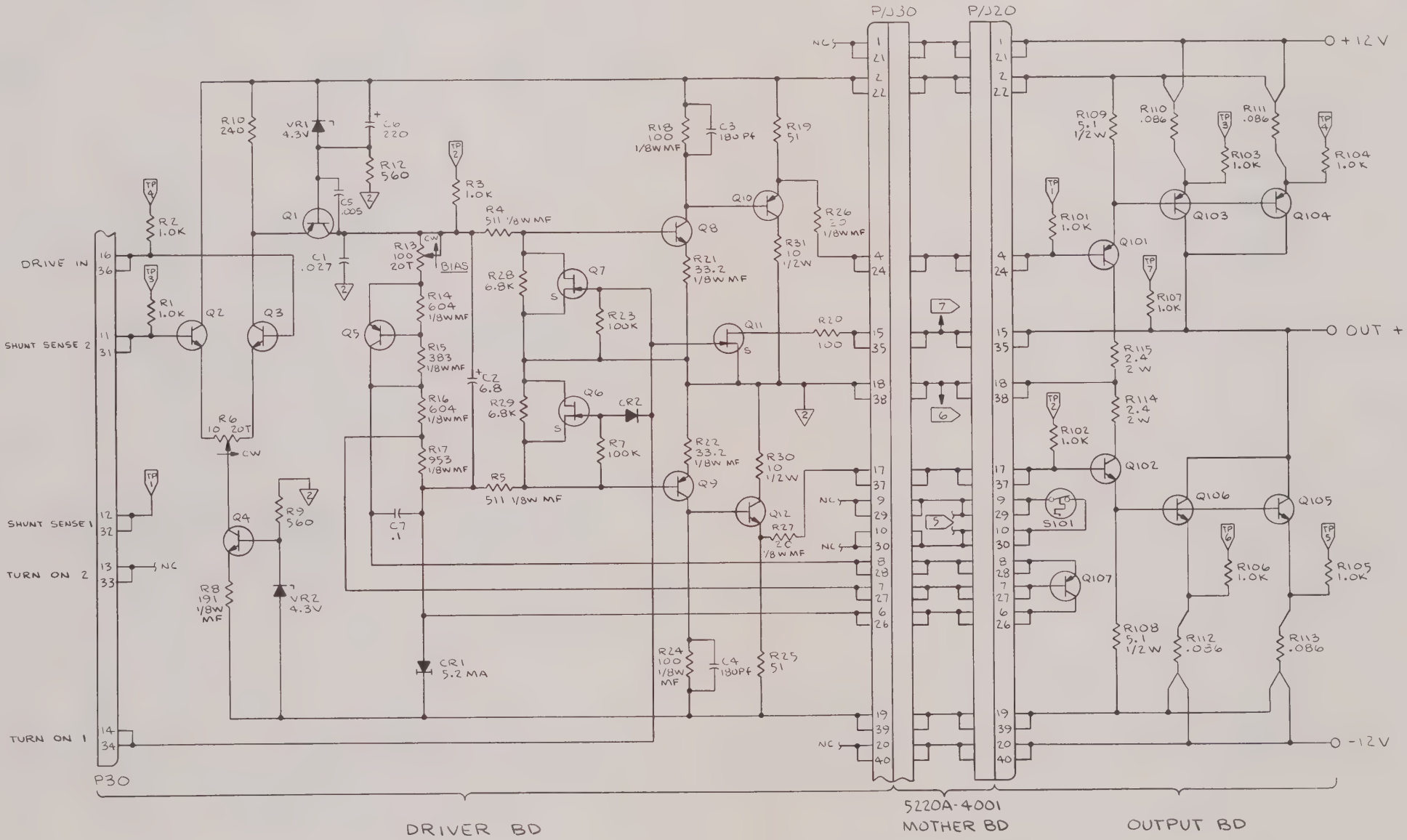


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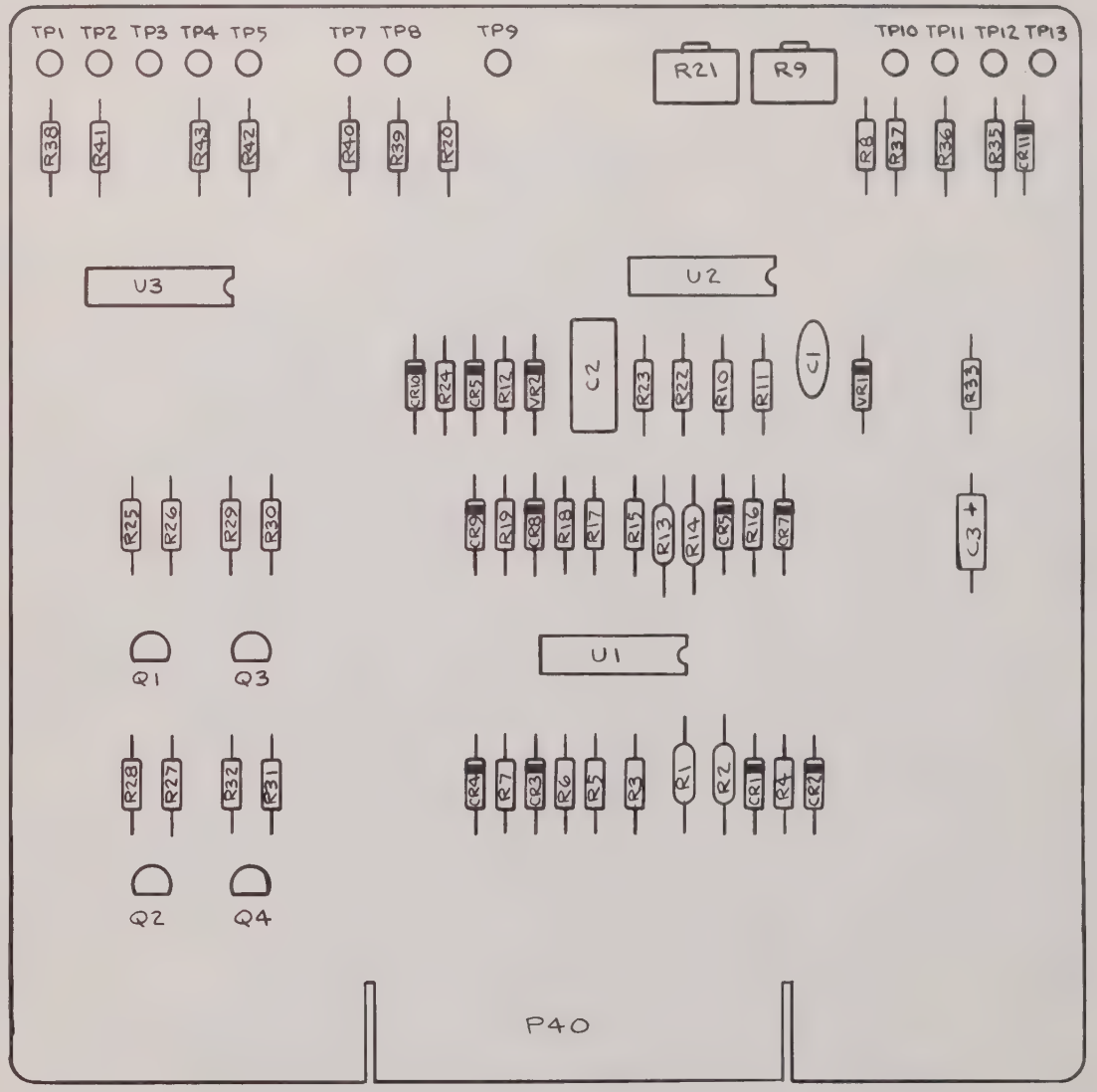
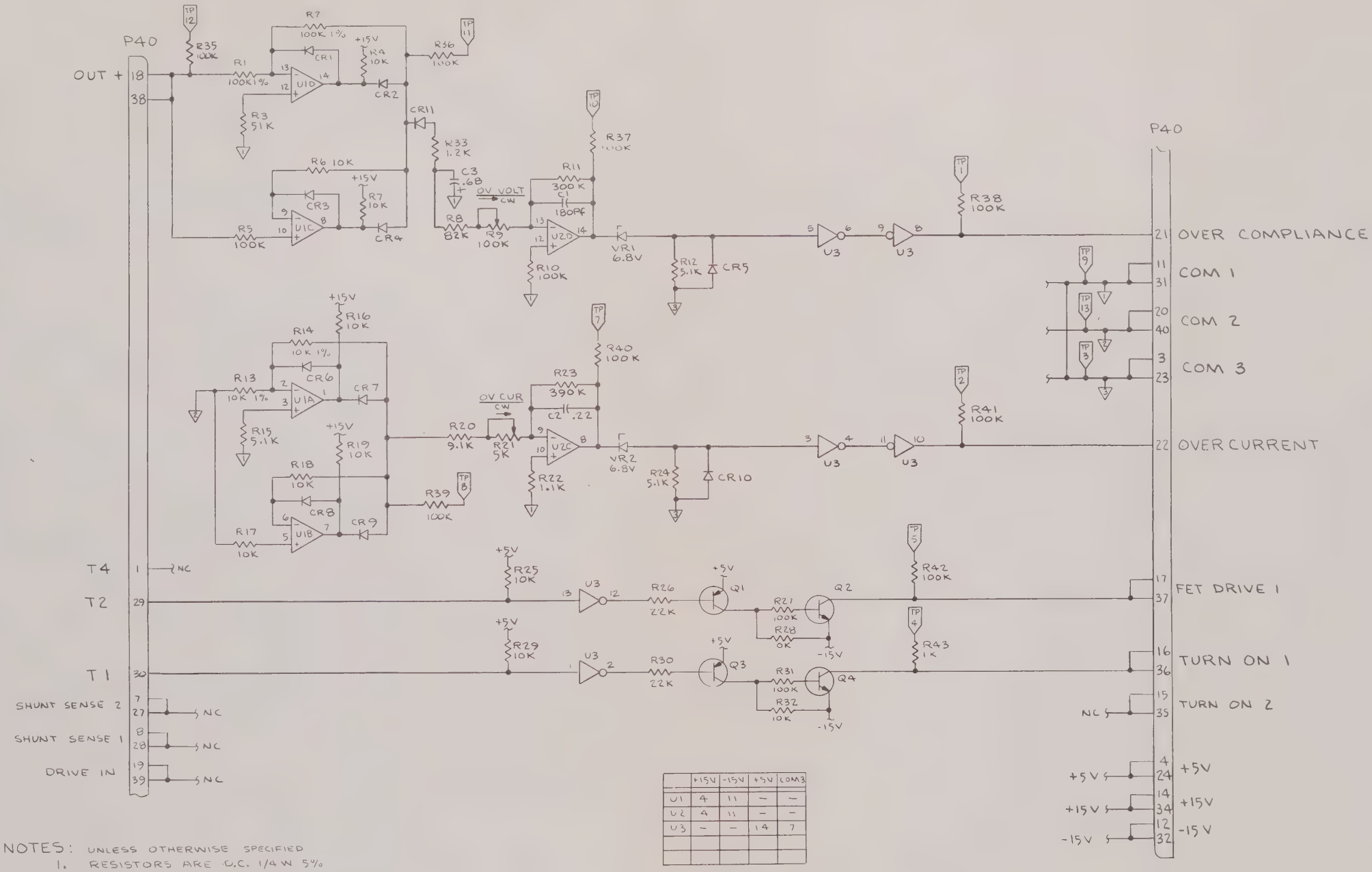
Figure 8-5. A6 Driver and A7 Output PCB Assemblies (cont)



5220A-1640

Figure 8-6. A8 Analog Control PCB Assembly

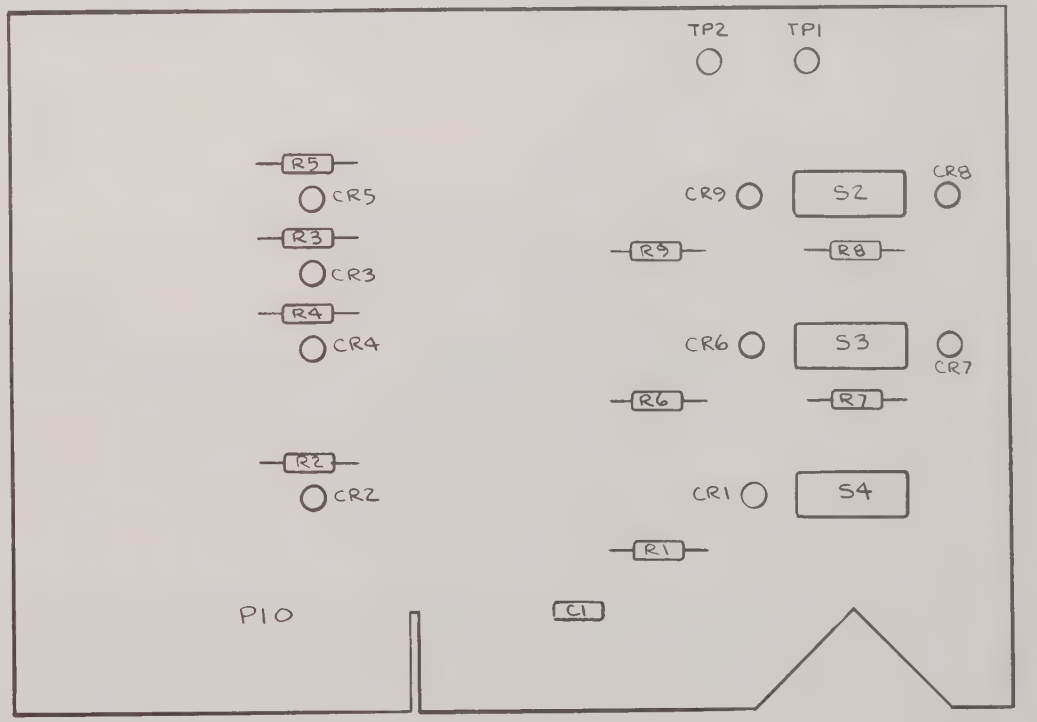


	+15V	-15V	+5V	COM3
U1	4	11	–	–
U2	4	11	–	–
U3	–	–	14	7

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE C.C. 1/4 W 5%
2. 1% RESISTORS ARE MF 1% T⁰ 1/8W
3. RESISTOR VALUES ARE IN OHMS
4. CAP VALUES ARE IN MICROFARADS

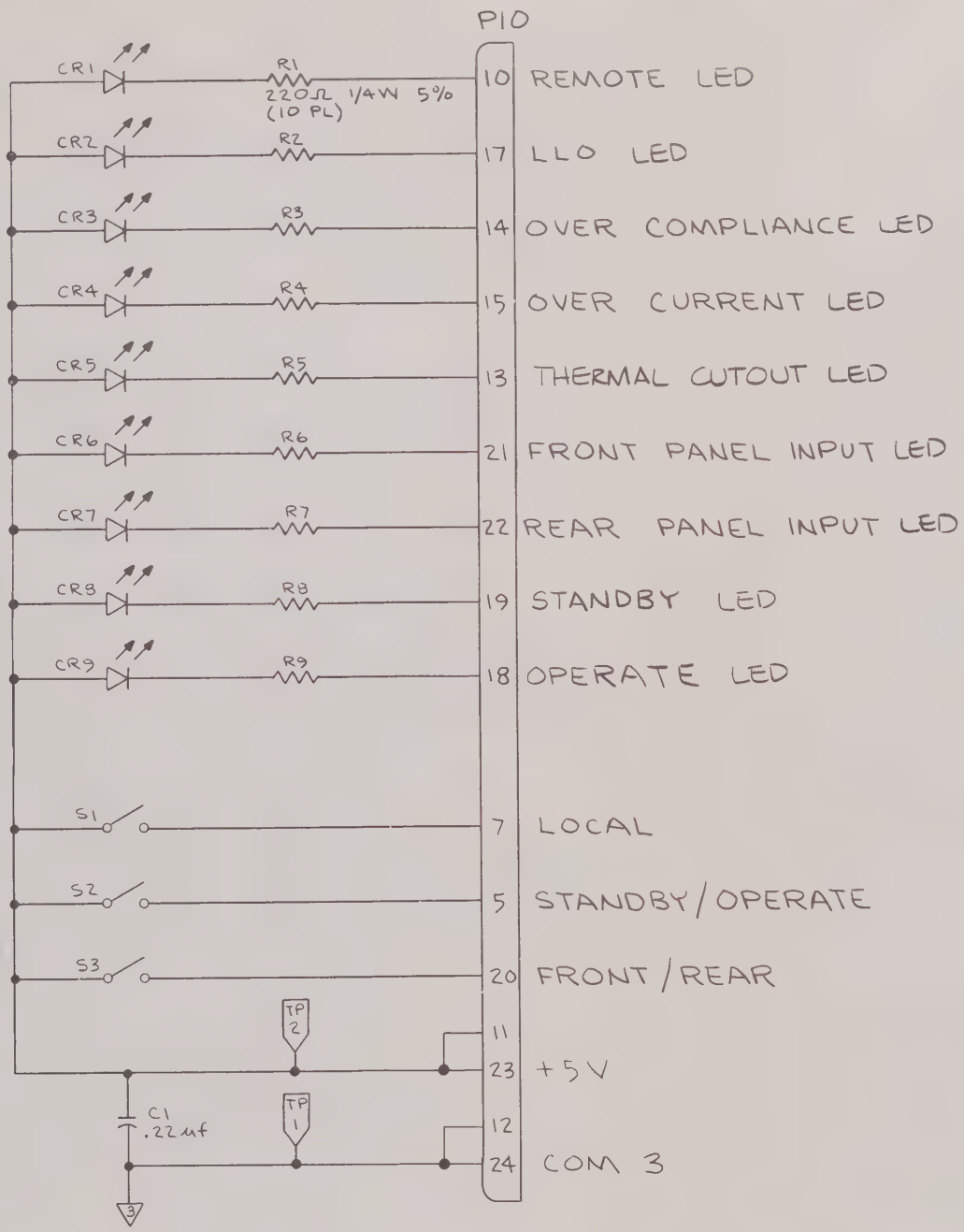
5220A-1040

Figure 8-6. A8 Analog Control PCB Assembly (cont)



5220A-1610

Figure 8-7. A9 Front Panel PCB Assembly



5220A-1010

Figure 8-7. A9 Front Panel PCB Assembly (cont)

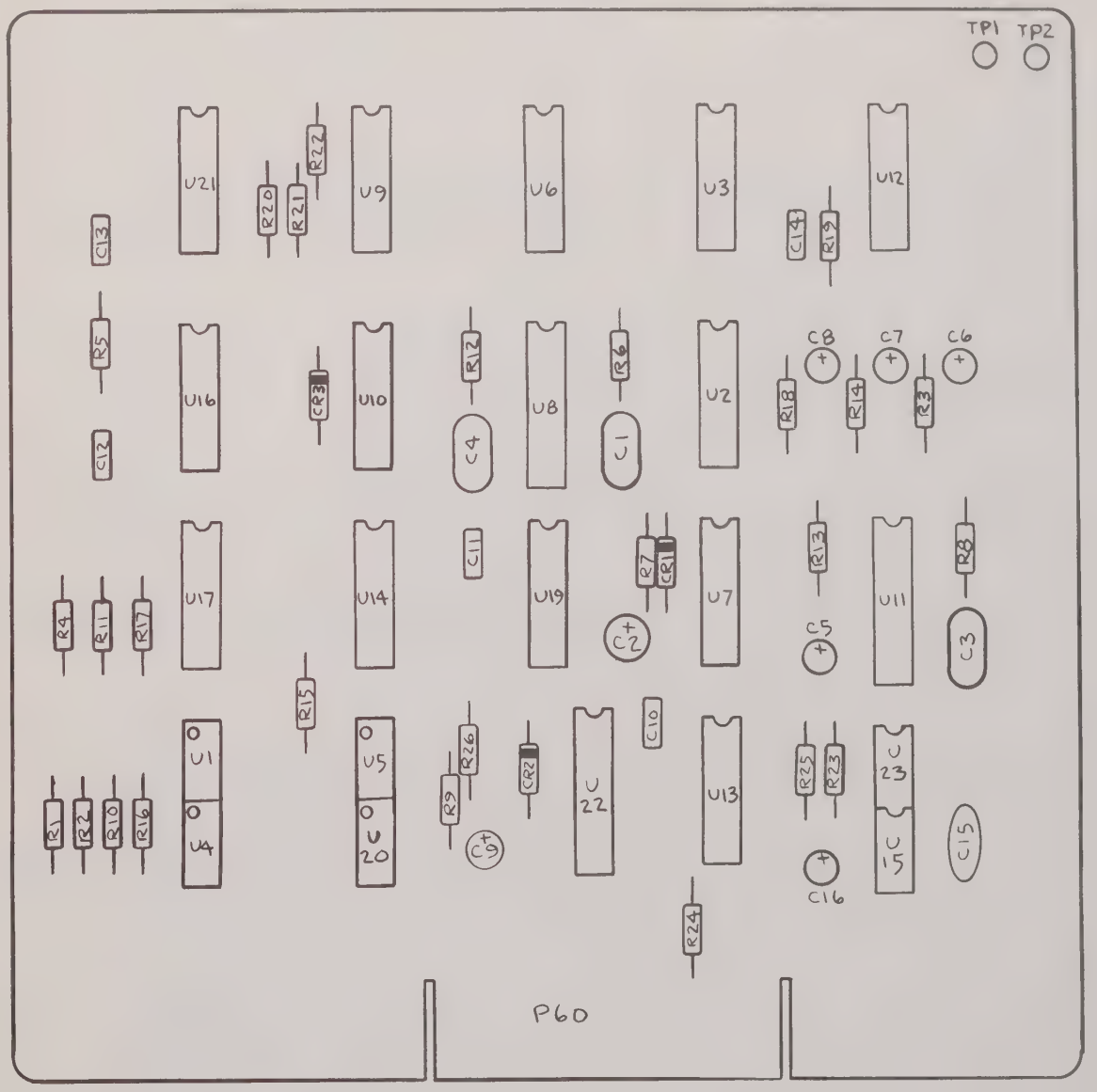


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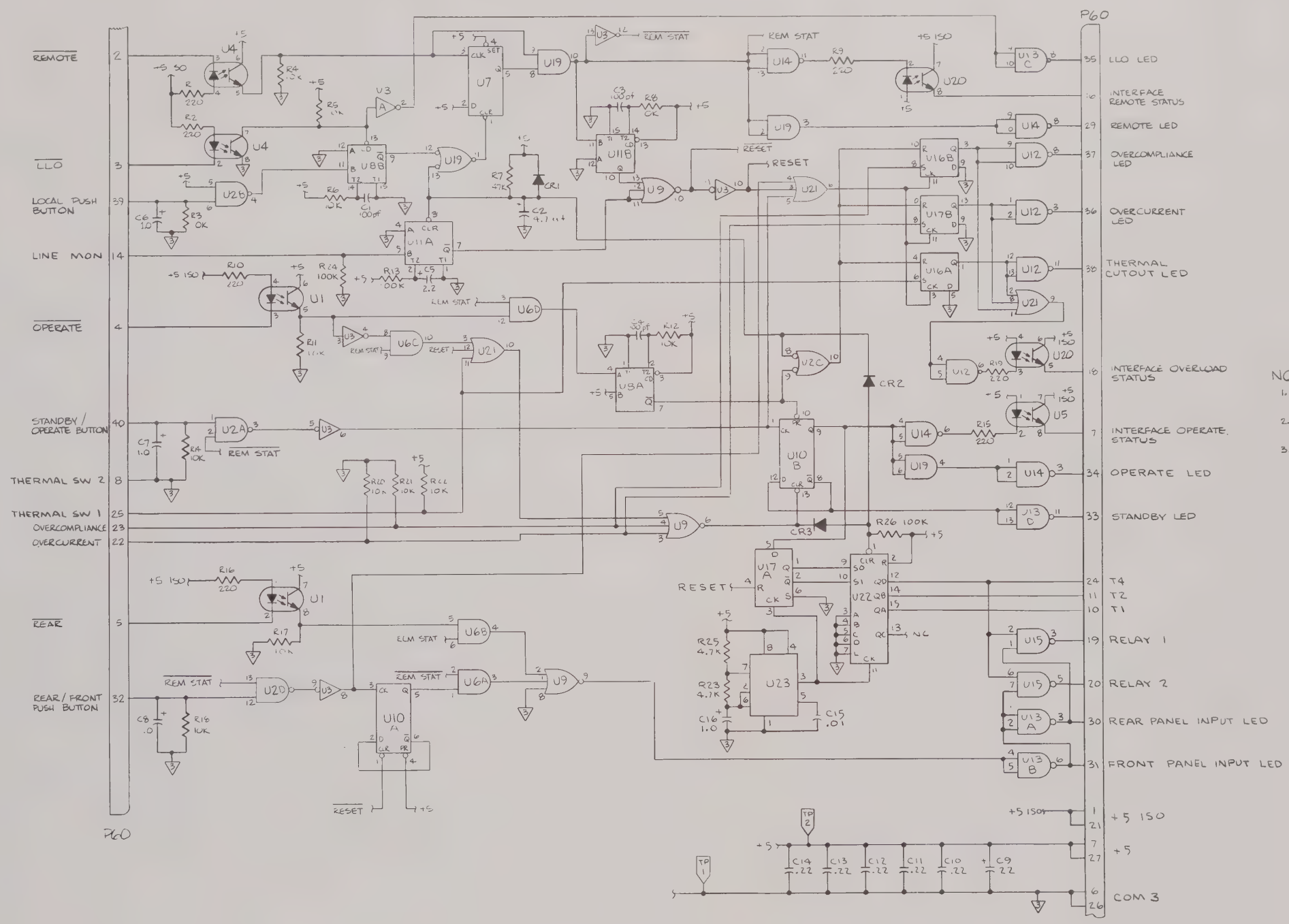
Figure 8-8. A10 Logic PCB Assembly



NOTES:

1. ALL RESISTORS ARE 4W, 5% & VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES ARE IN μF, UNLESS OTHERWISE SPECIFIED.
3. UNUSED.

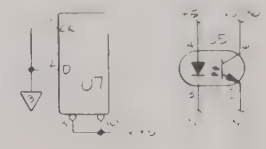


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Figure 8-8. A10 Logic PCB Assembly (cont)

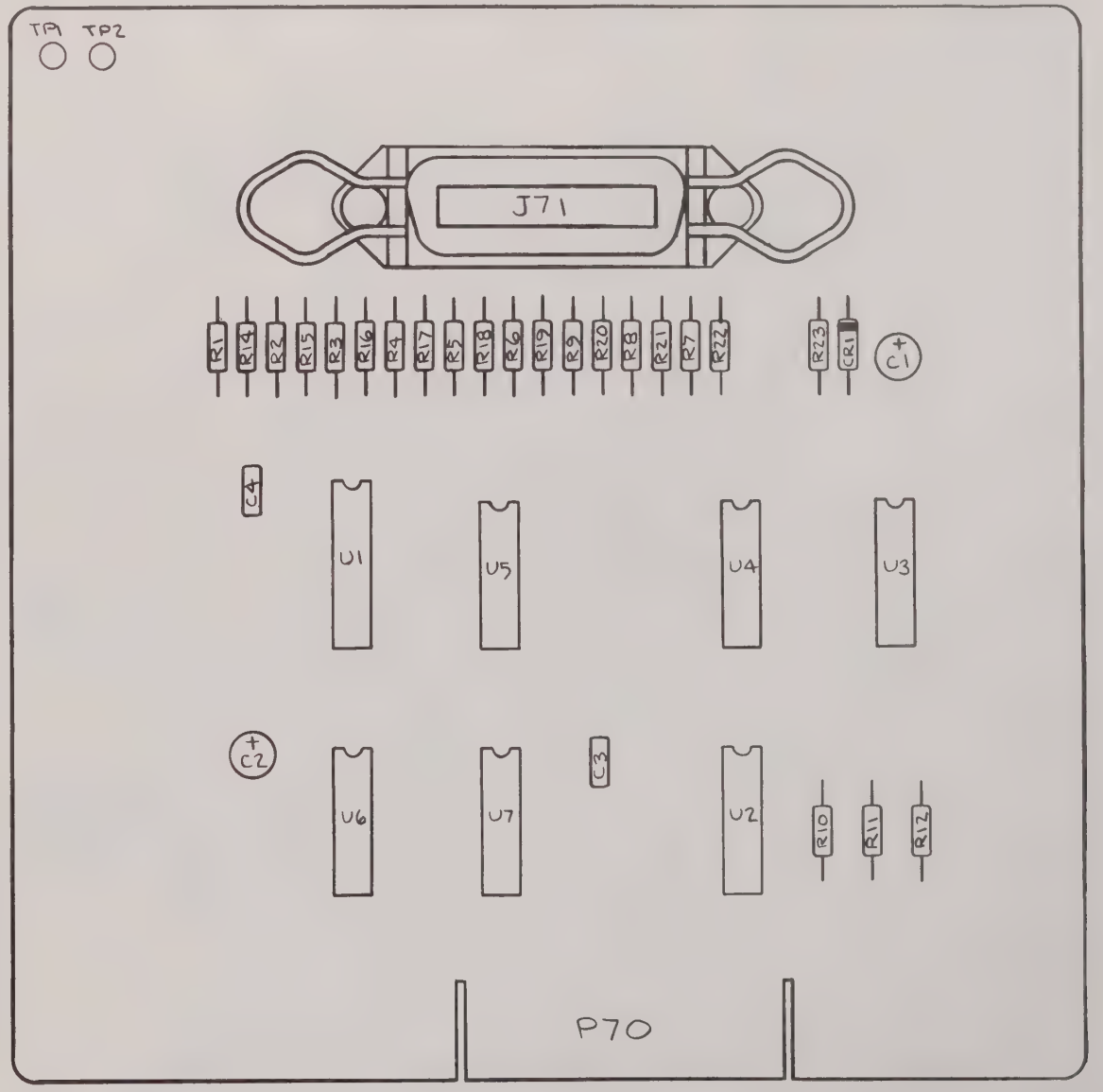

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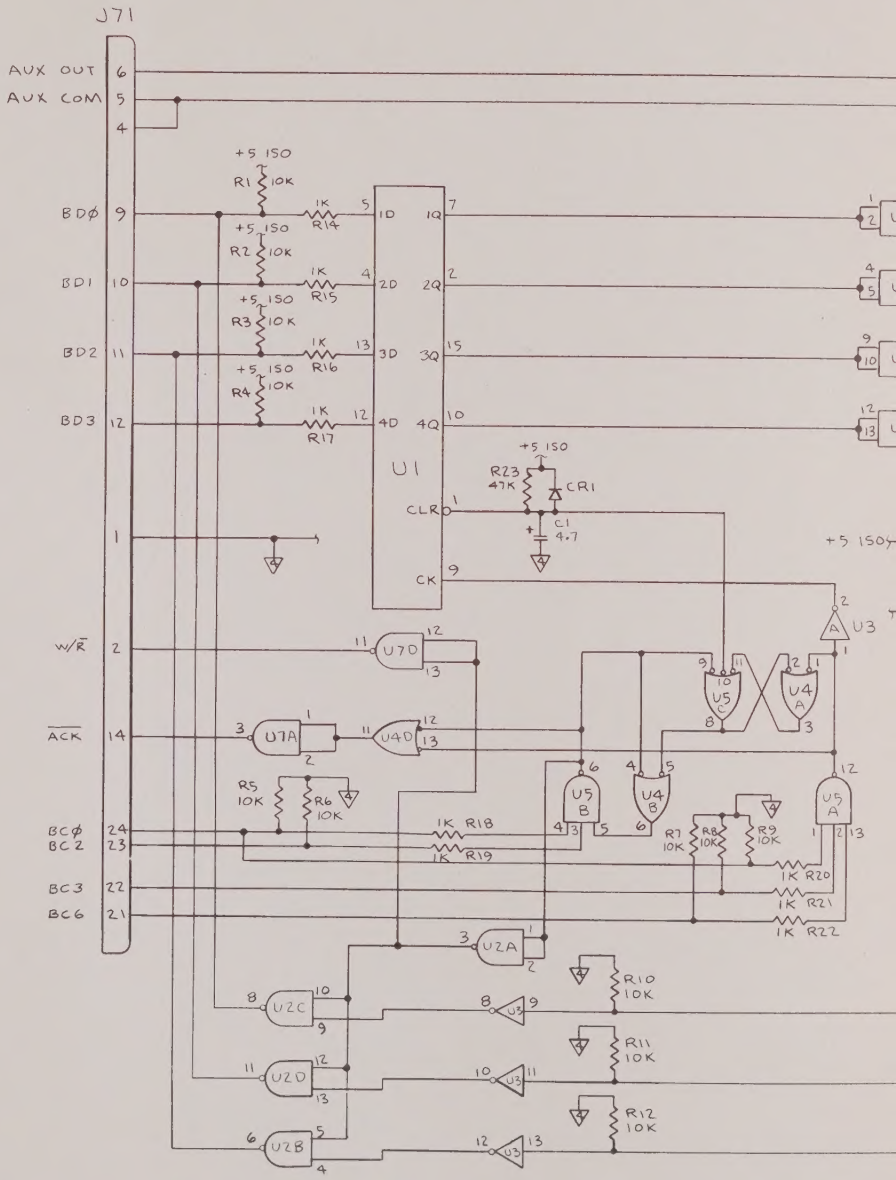
Figure 8-9. A11 MIS Bus Interface PCB Assembly


J71
AUX OUT
AUX COM
BDØ
BD1
BD2
BD3
W/R
ACK
BCØ
BC2
BC3
BC6
+5 ISO
R1 10K
R2 10K
R3 10K
R4 10K
1K R14
1K R15
1K R16
1K R17
U1
1D
2D
3D
4D
1Q
2Q
3Q
4Q
CLR
CK
R23 47K
CR1
C1 4.7
U7D
U7A
U4D
R5 10K
R6 10K
1K R18
1K R19
U5 B
U4 B
U5 A
U5 C
U4 A
U3 A
R7 10K
R8 10K
R9 10K
1K R20
1K R21
1K R22
U2A
U2C
U2D
U2B
R10 10K
R11 10K
R12 10K

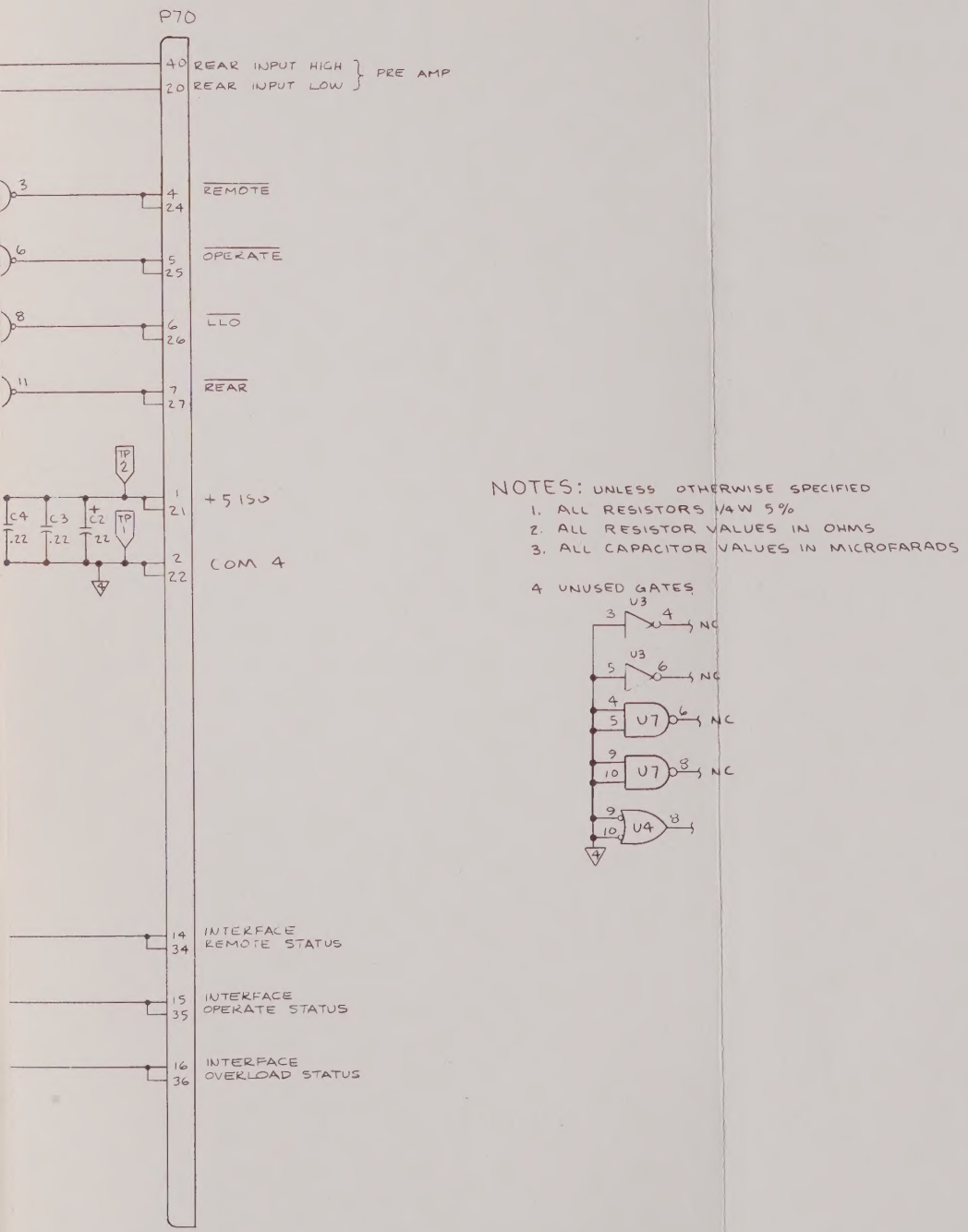


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Figure 8-9. A11 MIS Bus Interface PCB Assembly (cont)

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